# RISE IN COSTS OF IRRIGATION AND MULTIPURPOSE PROJECTS

## REPORT OF THE EXPERT COMMITTEE

MINISTRY OF IRRIGATION & POWER
GOVERNMENT OF INDIA
NEW DELHI
APRIL 1973

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सत्यमेव जयते

MINISTRY OF IRRIGATION & POWER
GOVERNMENT OF INDIA
NEW DELHI
APRIL, 1973

No. 1/1/72 - R&C
Government of India
Central Water & Power Commission
(Water Wing)

Bikaner House, Shahjahan Road,
New Delhi-11, April 27, 1973.

To

The Secretary to the Government of India,
Ministry of Irrigation & Power,
New Delhi.

Sir,

The Ministry of Irrigation & Power by their Resolution No. DW.II-34(2)/71 dated January 25, 1972 appointed a Committee of Experts to probe into the rise in costs of irrigation and multipurpose projects. After visiting some projects and deliberating over all facets of the subject in several meetings, the Committee gave useful guidelines on the basis of which the Member-Secretary ably produced the final draft report. The latter was debated upon by the members of the Committee with great interest for two days in the final meeting held on March 26-27, 1973, and was adopted with suggestions for certain verbal modifications. The Committee authorised its Chairman to finalise the report accordingly and submit it to the Ministry.

It gives me great pleasure to submit this final report herewith.

I would like to place on record my gratitude for the invaluable contributions made to our work by my distinguished colleagues, who ably represented varied disciplines like irrigation and hydro-power engineering, agronomy, economics, accountancy, finance, etc. Although they came from distant places in India and were very busy men, they took great interest in the work of the Committee and gave me the fullest cooperation without which it would not have been possible to produce this useful report.

The other acknowledgements have been given in the report itself.

Yours faithfully,

Sd/-
(J.P. NAEGAMVALA)
Member (W.R.), C.W. & P. C.

# A SUM-UP

* The seriousness of the problem of cost escalation and delay in execution of irrigation and multipurpose projects have been posed and the task of the Committee indicated (Ch. 1). Current status of major and medium projects (Ch. 2) are stated. The broad issues are clarified and an approach for study suggested (Ch. 3)...

** Formulation of water resources projects is discussed in the light of economic theory (Ch. 6), planning process (Ch. 4) and problems of measurement and projection (Ch. 7). Ideas for data collection, investigation and planning process are suggested (Ch. 4, 5, 6, 7).

*** Current practices and their consequences in terms of cost escalations and delay are examined for some of the important projects and suggestions offered for improvement (Ch. 8, 9, 10, 11, 12, 13).

**** Issues relating to execution, control and management are discussed by pooling results of Indian experience and comparing methods followed in some of the advanced countries (Ch. 14).

***** Basic arguments of the Report are briefly marshalled (Ch. 15), references to recommendations reproduced (Ch. 16) and acknowledgements are made to men, books and reports (Ch. 17).

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# 1. THE TASK

# 1. THE TASK

Since Independence, a large number of irrigation and multipurpose projects have been taken up for construction in the country. While the benefits of irrigation accruing from these projects have greatly helped in increasing agricultural production in the country, the mounting costs and the frequent revision of the project estimates and consequent delay in the completion of the projects and accrual of the benefits therefrom have been causing great concern to the Government. There has been no scientific investigation so far into the causes leading to the large number of revisions in project estimates. The Government of India, therefore, decided to refer this question to a Committee of Experts so that a sound policy could be framed for formulation and implementation of future irrigation and multipurpose projects.

2. The Committee constituted for the purpose by the Government of India in the Ministry of Irrigation & Power vide its Resolution No. DW.II-34(2)/71 dated 25th January, 1972 and as modified subsequently comprised the following:-

| | | |
|---|---|---|
| 1. | Shri J.P. Naegamvala,<br>Member (WR), C.W. & P.C. (WW)<br>and ex-officio Joint Secretary to the<br>Government of India,<br>Ministry of Irrigation & Power. | Chairman |
| 2. | Shri N.C. Saksena,<br>Engineer-in-Chief,<br>U.P. | Member |
| 3. | Shri S. Gopalan,<br>Chief Engineer (P.W.D.),<br>Major Irrigation and General,<br>Andhra Pradesh. | Member |
| 4. | Shri C.C. Patel,<br>Chief Engineer (Irrigation Projects)<br>and Additional Special Secretary,<br>P.W.D., Gujarat. | Member |
| 5. | Shri U.K. Verma,<br>Chief Engineer, Gandak Project,<br>Bihar. | Member |

|  |  |  |
|---|---|---|
| 6. | Dr. K.C. Thomas,<br>Chairman,<br>Himachal Pradesh State Electricity Board. | Member |
| 7. | Shri B.A. Ansari,<br>Chief Engineer, Hydro-Projects,<br>Maharashtra. | Member |
| 8. | Shri S.S. Apte,<br>Chief Engineer (Irrigation) and<br>Joint Secretary, I & P,<br>Maharashtra. | Member |
| 9. | Dr. N.D. Rege,<br>Jt. Commissioner<br>(Soil Conservation & Water Management),<br>Ministry of Agriculture. | Member |
| 10. | Dr. K. Venugopal,<br>National Council of Applied Economic Research,<br>New Delhi. | Member |
| 11. | Shri Prem Kumar,<br>Member (Accounts),<br>Gujarat State Electricity Board. | Member |
| 12. | Shri O.P. Chadha,<br>Chief (Irrigation), Planning Commission,<br>New Delhi. | Member |
| 13. | Shri S.T. Veeraraghavan,<br>F.O., Ministry of Finance. | Member |
| 14. | Shri B. Sen,<br>Director (Rates & Costs),<br>Central Water & Power Commission<br>(Water Wing), New Delhi. | Member-Secretary |

3. Specifying the terms of reference, the Resolution (see Appendix 1) stated:-

"The Committee will examine:

a) the adequacy or otherwise of the existing arrangements for the investigation and formulation of irrigation and multipurpose projects, preparation of feasibility reports and estimates thereof and construction programme including assessment of benefits;

b) the reasons for rise in the estimated costs of projects leading to their frequent revisions and recommend;

c) modification or revision in procedures for more realistic preparation of project feasibility reports and estimates as also improvement in the present system of implementation of projects to ensure their completion within the sanctioned estimated costs and according to the scheduled programmes of completion.

The Committee may invite, as and when necessary, other officers to participate in its discussion; it may visit irrigation and multipurpose projects in the States, if considered necessary. The Committee will submit its report by 30th June, 1972."

4. The date of submission of report was later extended by the Government to end of October, 1972. The Committee submitted an Interim Report to the Ministry of Irrigation & Power on 30 July, 1972. The date of submission of the final report was further extended to 31st March, 1973.

5. The Committee met five times of which the first and the last meetings were held in Delhi on 3rd March, 1972 and 26th & 27th March, 1973 respectively. The other three meetings were held at project sites. The members of the Committee visited Ramganga project at Kalagarh in Uttar Pradesh from 18th to 20th July, 1972. After inspection of the highly complicated works of this multipurpose project, the second meeting of the Committee was held here in which the Chief Engineer and his officers also participated. The members next visited Ukai project near Surat in Gujarat on 12th & 13th September, 1972. Here, the Committee had its third meeting along with the Chief Engineer in charge of the project and his Superintending Engineers. The members of the Committee also had the opportunity to see the almost completed Ukai dam and the power house under construction. The fourth meeting was held at the headquarters of the Beas-Sutlej Link project at Sundernagar in Himachal Pradesh from 29th September to 1st October, 1972. The Chief Engineer of the project with his large band of engineers, geologists, etc. joined the discussions. Here, during their visits to the construction sites, the members of the committee could also see for themselves the challenging problems of executing a tunnel oriented project in a virgin mountain like the Himalayas. At every place the members of the Committee discussed in detail the problems which the project officers experienced in executing their work.

6. In the chapters following have been explained in detail how the Committee went about its work, what was the methodology adopted for its enquiries, the outcome of the detailed case studies made and finally the findings and suggestions of the Committee on the various issues involved.

# 2. COST ESCALATION OF MAJOR IRRIGATION AND MULTIPURPOSE PROJECTS

## 2. COST ESCALATION OF MAJOR IRRIGATION AND MULTIPURPOSE PROJECTS

7. Before proceeding with the task systematically it may be interesting to review the status of the major and medium irrigation and multipurpose projects. According to the present definition, a project is considered 'medium' if it involves an expenditure of Rs. 25 lakhs or over (Rs. 30 lakhs in hilly areas). A project which involves an expenditure of Rs. 500 lakhs or over is called a 'major' project. Out of roughly 580 medium and major projects taken during the Plan period, 360 have been completed at a cost of Rs. 753 crores. About Rs. 1654 crores have been spent by now on the remaining 220 continuing projects.

8. Small projects do not produce problems whose impact on aggregate planning is of a very significant character. Their cost implications on the economy are of a small order. A realistic course of action, accordingly, would be to focus attention on major projects. Such projects are roughly 90 in number. Many of them are already completed. Out of 220 continuing projects, 64 were singled out as 'major projects'. **Appendix 2: Cost Escalation of Major Irrigation and Multipurpose Projects** gives the name of those projects by States, their dates of sanction, first estimate and revised estimate in crores of rupees and percentage rise of the revised estimate over the first estimate. The following table summarises the information by States.

1. Cost Escalation of Major Irrigation and Multipurpose Projects
( By States )

| State | No. of projects | Period | Estimate (Rs.Crores) | | Percentage rise $\left[\frac{(4.2-4.1)}{4.1} \times 100\right]$ |
|---|---|---|---|---|---|
| | | | First @ £ | Revised @# | |
| 1 | 2 | 3 | 4.1 | 4.2 | 5 |
| INDIA | 64 | 1946-69 | 1503(100) | 3127(100) | 108 |
| 1. Andhra Pradesh [a] | 6 | 1951-67 | 198( 13) | 443( 14) | 124 |
| 2. Bihar [b] | 7 | 1956-68 | 142( 9) | 417( 13) | 194 |

| 1 | 2 | 3 | 4.1 | 4.2 | 5 |
|---|---|---|---|---|---|
| 3. Gujarat | 5 | 1948-66 | 128( 9) | 281( 9) | 119 |
| 4. Haryana [c] | 2 | 1951-66 | 11( 1) | 26( 1) | 136 |
| 5. Kerala | 7 | 1957-66 | 34( 2) | 115( 4) | 238 |
| 6. Madhya Pradesh [d] | 6 | 1951-67 | 78( 5) | 178( 6) | 128 |
| 7. Maharashtra | 13 | 1957-68 | 235(16) | 392(12) | 67 |
| 8. Mysore | 6 | 1947-63 | 106( 7) | 315(10) | 197 |
| 9. Orissa | 3 | 1947-59 | 67( 4) | 150( 5) | 124 |
| 10. Punjab [e] | 2 | 1963-69 | 260(17) | 373(12) | 43 |
| 11. Rajasthan | 1 | 1957 | 66( 5) | 119( 4) | 80 |
| 12. Tamil Nadu | 2 | 1962-64 | 32( 2) | 57( 2) | 78 |
| 13. Uttar Pradesh | 2 | 1959-68 | 105( 7) | 193( 6) | 84 |
| 14. West Bengal | 2 | 1946-61 | 41( 3) | 66( 2) | 61 |

@ Figures in parentheses ( ) indicate percentage share of each State on aggregate national estimate for all the 64 projects.

£ As approved.

# From annual plan discussions 1972-73.

[a] Covers 3 projects viz. Tungabhadra H.L.C.Stage I, Stage II and Tungabhadra which benefit Mysore also.

[b] Covers two projects viz. Gandak and Western Kosi Canal which benefit Uttar Pradesh and Nepal also.

[c] Covers one project viz. Gurgaon Canal which benefits Rajasthan also.

[d] Covers two projects viz. Chambal Stage I and Stage II which benefit Rajasthan also.

[e] Covers two projects viz, Beas Unit I and Unit II which benefit Haryana and Rajasthan also. See also foot-note in Appendix 2.

It will be seen that the overall percentage rise of the revised estimate compared to the original estimate for all the 64 continuing major projects is of the order of 108. It varies from State to State, the minimum is 43 and the maximum is 238. More than half of the major projects costing roughly Rs. 2,000 crores, which is about 64 per cent of the aggregate cost of all the 64 major continuing projects, are located in 5 States. They are Andhra Pradesh, Bihar, Maharashtra, Punjab and Mysore.

9. The following table identifies the 32 projects whose cost escalation is 100 per cent or more:-

### 2. High Cost Escalation [1]

| S.No.<br>0 | Project<br>1 | Revised estimate (Rs. crores)<br>2 | Percentage rise<br>3 |
|---|---|---|---|
| | 1. **Andhra Pradesh** (6) | | |
| 1. | 1.1 Nagarjunasagar | 250 | 172 |
| | 2. **Bihar** (7) | | |
| 2. | 2.1 Chandan Reservoir | 10 | 194 |
| 3. | 2.2 Gandak [a] | 219 | 321 |
| 4. | 2.3 Kosi | 112 | 150 |
| 5. | 2.4 Rajpur Canal | 10 | 108 |
| 6. | 2.5 Western Kosi Canal [b] | 37 | 173 |
| | 3. **Gujarat** (5) | | |
| 7. | 3.1 Kakrapar | 19 | 202 |
| 8. | 3.2 Mahi Stage I | 25 | 480 |
| 9. | 3.3 Narmada (Broach) | 108 | 150 |

| 0 | | 1 | 2 | 3 |
|---|---|---|---|---|
| | 4. | **Haryana (2)** | | |
| 10. | | 4.1 W.J.C. Remodelling | 12 | 314 |
| | 5. | **Kerala (7)** | | |
| 11. | | 5.1 Chitturpuzha | 5 | 701 |
| 12. | | 5.2 Kallada | 45 | 230 |
| 13. | | 5.3 Kanhirapuzha | 9 | 154 |
| 14. | | 5.4 Kuttiadi | 13 | 154 |
| 15. | | 5.5 Pamba | 18 | 367 |
| 16. | | 5.6 Pazhassi | 13 | 199 |
| 17. | | 5.7 Periyar Valley | 12 | 230 |
| | 6. | **Madhya Pradesh (6)** | | |
| 18. | | 6.1 Chambal Stage I c/ | 85 | 146 |
| [illegible] | | 6.2 Hasdeo | 10 | 207 |
| 2[illegible] | | 6.3 Hasdeo R.B.C. | 11 | 129 |
| 2[illegible] | | 6.4 Tawa | 48 | 137 |
| | 7. | **Maharashtra (13)** | | |
| 22. | | 7.1 Khadakwasla Stage I | 30 | 152 |
| 23. | | 7.2 Mula | 22 | 149 |
| | 8. | **Mysore (6)** | | |
| 24. | | 8.1 Bhadra | 41 | 417 |
| 25. | | 8.2 Ghataprabha Stage II | 49 | 268 |
| 26. | | 8.3 Kabini | 35 | 1300 |
| 27. | | 8.4 Malaprabha | 68 | 253 |
| 28. | | 8.5 Upper Krishna Stage I | 117 | 100 |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
|  | 9. Orissa (3) |  |  |
| 29. | 9.1 Mahanadi Delta | 68 | 358 |
| 30. | 9.2 Salandi | 14 | 206 |
|  | 10. Tamil Nadu (2) |  |  |
| 31. | 10.1 Parambikulam Aliyar | 50 | 101 |
|  | 11. Uttar Pradesh (2) |  |  |
| 32. | 11.1 Ramganga d/ | 128 | 222 |

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1/ Figures in parentheses ( ) indicate number of major continuing projects in the State.

a/ Covers also Uttar Pradesh and Nepal. Rise in Bihar estimate including Nepal is 345%. Rise in U.P. estimate excluding Nepal is 238%.

b/ Covers also U.P. and Nepal. Although approved in 1961, the work started in 1972.

c/ Covers also Rajasthan.

d/ The base of comparison is the first estimate approved by the Planning Commission in 1959. Compared to estimate sanctioned by State Government in 1961, the percentage would read 90.

10. The following table gives the frequency distribution of projects under high cost escalation groups:-

### 3. High Cost Escalation Groups
(Frequency distribution)

| Percentage increase | No. of projects | Serial Numbers |
|---|---|---|
| 1 | 2 | 3 |
| Total | 32 | |
| 100 - 200 | 16 | 1, 2, 4, 5, 6, 9, 13, 14, 16, 18, 20, 21, 22, 23, 28, 31 |
| 201 - 300 | 8 | 7, 12, 17, 19, 25, 27, 30, 32 |
| 301 - 400 | 4 | 3, 10, 15, 29 |
| 401 and above | 4 | 8, 11, 24, 26 |

11. The following table identifies the 16 projects whose cost escalation is between 50 and 99 percent:-

### 4. Medium Cost Escalation [1]

| S. No. | Project | Revised estimate (Rs. crores) | Percentage rise |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| | 1. Andhra Pradesh (6) | | |
| 1. | 1.1 Pochampad | 76 | 89 |
| 2. | 1.2 Tungabhadra H.L.C. Stage I [a] | 24 | 88 |
| 3. | 1.3 Tungabhadra [a] | 65 | 94 |
| | 2. Bihar (7) | | |
| 4. | 2.1 Sone H.L.C. | 13 | 53 |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| | 3. Gujarat (5) | | |
| 5. | 3.1 Ukai | 109 | 86 |
| | 4. Haryana (2) | | |
| 6. | 4.1 Gurgaon Canal[b] | 13 | 63 |
| | 5. Madhya Pradesh (6) | | |
| 7. | 5.1 Barna | 9 | 67 |
| 8. | 5.2 Chambal Stage II[c] | 14 | 50 |
| | 6. Maharashtra (13) | | |
| 9. | 6.1 Bagh | 11 | 83 |
| 10. | 6.2 Jayakwadi Stage I | 74 | 93 |
| 11. | 6.3 Krishna | 50 | 80 |
| 12. | 6.4 Kukadi Stage I | 27 | 54 |
| 13. | 6.5 Warna | 57 | 84 |
| | 7. Punjab (2) | | |
| 14. | 7.1 Beas Unit I[d] | 180 | 86 |
| | 8. Rajasthan (1) | | |
| 15. | 8.1 Rajasthan Canal Stage I | 119 | 89 |
| | 9. West Bengal (2) | | |
| 16. | 9.1 Kangsabati | 46 | 82 |

[1] Figures in parentheses ( ) indicate the number of major continuing projects in the State.

[a] Covers also Mysore.

[b] Covers also Rajasthan.

[c] Covers also Rajasthan.

[d] Covers also Haryana and Rajasthan.

12. The following table gives the frequency distribution of projects under medium cost escalation groups:-

### 5. Medium Cost Escalation Groups
(Frequency distribution)

| Percentage increase in cost | No. of projects | Serial Numbers |
|---|---|---|
| 1 | 2 | 3 |
| Total | 16 | |
| 50 - 70 | 5 | 4, 6, 7, 8, 12 |
| 71 - 90 | 9 | 1, 2, 5, 9, 11,<br>13, 14, 15, 16 |
| 91 - 99 | 2 | 3, 10 |

13. The following table identifies the 16 projects whose cost escalation is below 50 per cent:-

### 6. Low Cost Escalation[1/]

| S. No. | Project | Revised estimate (Rs. crores) | Percentage rise |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| | 1. Andhra Pradesh (6) | | |
| 1. | 1.1 Kaddam | 8 | 49 |
| 2. | 1.2 Tungabhadra H.L.C. Stage II[a/] | 20 | 36 |
| | 2. Bihar (7) | | |
| 3. | 2.1 Sone Barrage Remodelling & Link Canal | 16 | 11 |
| | 3. Gujarat (5) | | |
| 4. | 3.1 Mahi Stage II (Kadana) | 21 | 29 |
| | 4. Maharashtra (13) | | |
| 5. | 4.1 Bhima | 62 | 46 |
| 6. | 4.2 Girna | 15 | 18 |

| 0 | | 1 | 2 | 3 |
|---|---|---|---|---|
| 7. | | 4.3 Itiadoh | 8 | 16 |
| 8. | | 4.4 Purna | 17 | 29 |
| 9. | | 4.5 Pus | 5 | 49 |
| 10. | | 4.6 Upper Godavari | 14 | nil |
| | 5. | Mysore (6) | | |
| 11. | | 5.1 Ghataprabha Stage I | 7 | 27 |
| | 6. | Orissa (3) | | |
| 12. | | 6.1 Hirakud Stage I | 68 | 42 |
| | 7. | Punjab (2) | | |
| 13. | | 7.1 Beas Unit II[b] | 193 | 18 |
| | 8. | Tamil Nadu (2) | | |
| 14. | | 8.1 Chittarpattanamkal | 7 | 2 |
| | 9. | Uttar Pradesh (2) | | |
| 15. | | 9.1 Improvement to Lower Sarda Canal System (Stage I) | 65 | nil |
| | 10. | West Bengal (2) | | |
| 16. | | 10.1 Mayurakshi | 20 | 32 |

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[1] Figures in parentheses ( ) indicate number of major continuing projects in the State.

[a] Covers also Mysore.

[b] Covers also Haryana and Rajasthan.

14. The following table gives the frequency distribution of projects under low cost escalation groups:-

### 7. Low Cost Escalation Groups
(Frequency distribution)

| Percentage increase in cost | No. of projects | Serial Numbers |
|---|---|---|
| 1 | 2 | 3 |
| Total | 16 | |
| Below 10 | 3 | 10, 14, 15 |
| 10 - 29 | 7 | 3, 4, 6, 7, 8, 11, 13 |
| 30 - 49 | 6 | 1, 2, 5, 9, 12, 16 |

15. The following table gives the frequency distribution of projects in a two-way table. On one side is given the groups in terms of revised estimates measured in crores of rupees and on the other side is indicated the cost escalation groups - High, Medium and Low as defined in the preceding paragraphs:-

### 8. Distribution of Projects by Revised Estimates Groups
( By High, Medium and Low Cost Escalation )

| Revised estimate Rs. Crores | Cost Escalation Groups | | | |
|---|---|---|---|---|
| | Total | High | Medium | Low |
| 1 | 2.0 | 2.1 | 2.2 | 2.3 |
| All Groups | 64 | 32 | 16 | 16 |
| 201 - 300 | 2 | 2 | - | - |
| 101 - 200 | 8 | 4 | 3 | 1 |
| 71 - 100 | 3 | 1 | 2 | - |
| 51 - 70 | 7 | 2 | 2 | 3 |
| 31 - 50 | 9 | 7 | 2 | - |
| 26 - 30 | 2 | 1 | 1 | - |
| 21 - 25 | 4 | 2 | 1 | 1 |

| 1 | 2.0 | 2.1 | 2.2 | 2.3 |
|---|---|---|---|---|
| 16 - 20 | 6 | 2 | - | 4 |
| 11 - 15 | 12 | 6 | 4 | 2 |
| 0 - 10 | 11 | 5 | 1 | 5 |

16. It will be seen that there were 20 projects whose revised estimates exceeded 50 crores of rupees. Among these, 9 came under the high cost escalation group, 7 under the medium cost escalation group and 4 under the low cost escalation group. It may be useful now to divide the major continuing projects into three groups - large, medium and small - according to the size of their revised cost estimate. Large projects are defined as those projects whose cost estimates exceed a sum of Rs. 100 crores. Medium projects are defined as those projects whose cost estimates lie between Rs. 51 crores and Rs. 100 crores. Small project is defined as that project whose cost estimate is Rs. 50 crores or below.

17. The following table gives the names of the 10 large projects identifying each one of them in terms of their cost escalation:-

### 9. Cost Escalation of Large Projects

| S.No. 0 | Project 1 | Revised estimate 1/ 2 | Percentage rise 3 |
|---|---|---|---|
| | 1. **Andhra Pradesh** (6) | | |
| 1. | 1.1 Nagarjunasagar | 250 | 172 (High) |
| | 2. **Bihar** (7) | | |
| 2. | 2.1 Gandak a/ | 219 | 321 (High) |
| 3. | 2.2 Kosi | 112 | 150 (High) |
| | 3. **Gujarat** (5) | | |
| 4. | 3.1 Narmada (Broach) | 108 | 150 (High) |
| 5. | * 3.2 Ukai | 109 | 86 (Medium) |
| | 4. **Mysore** (6) | | |
| 6. | 4.1 Upper Krishna Stage I | 117 | 100 (High) |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| | 5. Punjab (2) | | |
| 7. | *5.1 Beas Unit I [b] | 180 | 86 (Medium) |
| 8. | 5.2 Beas Unit II [b] | 193 | 18 (Low) |
| | 6. Rajasthan (1) | | |
| 9. | 6.1 Rajasthan Canal Stage I | 119 | 89 (Medium) |
| | 7. Uttar Pradesh (2) | | |
| 10. | *7.1 Ramganga | 128 | 222 (High) |

[1] From annual plan discussions 1972-73.

[2] Figures in parentheses ( ) indicate number of major continuing projects in the State.

[a] Covers also Uttar Pradesh and Nepal.

[b] Covers also Haryana and Rajasthan.

* Project included for detailed study.

18. The following table gives the names of the 10 medium projects identifying each one of them in terms of their cost escalation:-

10. Cost Escalation of Medium Projects

| S.No. | Project [2] | Revised estimated [1] (Rs.crores) | Percentage rise |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| | 1. Andhra Pradesh (6) | | |
| 1. | 1.1 Pochampad | 76 | 89 (Medium) |
| 2. | 1.2 Tungabhadra [a] | 65 | 94 (Medium) |
| | 2. Madhva Pradesh (6) | | |
| 3. | 2.1 Chambal Stage I [b] | 85 | 146 (High) |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
|  | 3. Maharashtra (13) |  |  |
| 4. | 3.1 Bhima | 62 | 46 (Low) |
| 5. | *3.2 Jayakwadi Stage I | 74 | 93 (Medium) |
| 6. | 3.3 Warna | 57 | 84 (Medium) |
|  | 4. Mysore (6) |  |  |
| 7. | 4.1 Malaprabha | 68 | 253 (High) |
|  | 5. Orissa (3) |  |  |
| 8. | 5.1 Hirakud Stage I | 68 | 42 (Low) |
| 9. | 5.2 Mahanadi Delta | 68 | 358 (High) |
|  | 6. Uttar Pradesh (2) |  |  |
| 10. | 6.1 Improvement to Lower Sarda Canal System (Stage I) | 65 | Nil |

1/ From annual plan discussions 1972-73.

2/ Figures in parentheses ( ) indicate number of major continuing projects in the State.

a/ Covers also Mysore.

b/ Covers also Rajasthan.

* Project included for detailed study.

19. The following table gives the names of the 44 small projects identifying each one of them in terms of their cost escalation:-

### 11. Cost Escalation of Small Projects

| S. No. | Project 2/ | Revised estimate 1/ (Rs. crores) | Percentage rise |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
|  | 1. Andhra Pradesh (6) |  |  |
| 1. | 1.1 Kaddam | 8 | 49 (Low) |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| 2. | 1.2 Tungabhadra H.L.C. Stage I[a] | 24 | 88 (Medium) |
| 3. | 1.3 Tungabhadra H.L.C. Stage II[a] | 20 | 36 (Low) |
|  | 2. Bihar (7) |  |  |
| 4. | 2.1 Chandan Reservoir | 10 | 194 (High) |
| 5. | 2.2 Rajpur Canal | 10 | 108 (High) |
| 6. | 2.3 Sone Barrage Remodelling & Link Canal | 16 | 11 (Low) |
| 7. | 2.4 Sone H. L. C. | 13 | 53 (Medium) |
| 8. | 2.5 Western Kosi Canal[b] | 37 | 173 (High) |
|  | 3. Gujarat (5) |  |  |
| 9. | 3.1 Kakrapar | 19 | 202 (High) |
| 10. | 3.2 Mahi Stage I | 25 | 480 (High) |
| 11. | 3.3 Mahi Stage II (Kadana) | 21 | 29 (Low) |
|  | 4. Haryana (2) |  |  |
| 12. | 4.1 Gurgaon Canal[c] | 13 | 63 (Medium) |
| 13. | 4.2 W.J.C. Remodelling | 12 | 314 (High) |
|  | 5. Kerala (7) |  |  |
| 14. | 5.1 Chitturpuzha | 5 | 701 (High) |
| 15. | *5.2 Kallada | 45 | 230 (High) |
| 16. | 5.3 Kanhirapuzha | 9 | 154 (High) |
| 17. | 5.4 Kuttiadi | 13 | 154 (High) |
| 18. | 5.5 Pamba | 18 | 367 (High) |
| 19. | 5.6 Pazhassi | 13 | 199 (High) |
| 20. | 5.7 Periyar Valley | 12 | 230 (High) |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
|  | 6. Madhya Pradesh (6) |  |  |
| 21. | 6.1 Barna | 9 | 67 (Medium) |
| 22. | 6.2 Chambal Stage II[d] | 14 | 50 (Medium) |
| 23. | 6.3 Hasdeo | 10 | 207 (High) |
| 24. | 6.4 Hasdeo R. B. C. | 11 | 129 (High) |
| 25. | 6.5 Tawa | 48 | 137 (High) |
|  | 7. Maharashtra (13) |  |  |
| 26. | 7.1 Bagh | 11 | 83 (Medium) |
| 27. | 7.2 Girna | 15 | 18 (Low) |
| 28. | 7.3 Itiadoh | 8 | 16 (Low) |
| 29. | 7.4 Khadakwasla Stage I | 30 | 152 (High) |
| 30. | 7.5 Krishna | 50 | 80 (Medium) |
| 31. | 7.6 Kukadi Stage I | 27 | 54 (Medium) |
| 32. | 7.7 Mula | 22 | 149 (High) |
| 33. | 7.8 Purna | 17 | 29 (Low) |
| 34. | 7.9 Pus | 5 | 49 (Low) |
| 35. | 7.10 Upper Godavari | 14 | Nil |
|  | 8. Mysore (6) |  |  |
| 36. | 8.1 Bhadra | 41 | 417 (High) |
| 37. | 8.2 Ghataprabha Stage I | 7 | 27 (Low) |
| 38. | 8.3 Ghataprabha Stage II | 49 | 268 (High) |
| 39. | 8.4 Kabini | 35 | 1300 (High) |
|  | 9. Orissa (3) |  |  |
| 40. | 9.1 Salandi | 14 | 206 (High) |

| 0 | 1 | 2 | 3 |
|---|---|---|---|
| | 10. Tamil Nadu (2) | | |
| 41. | 10.1 Parambikulam Aliyar | 50 | 101 (High) |
| 42. | 10.2 Chittarpattanamkal | 7 | 2 (Low) |
| | 11. West Bengal (2) | | |
| 43. | * 11.1 Kangsabati | 46 | 82 (Medium) |
| 44. | 11.2 Mayurakshi | 20 | 32 (Low) |

1/ From annual plan discussions 1972-73.

2/ Figures in parentheses ( ) indicate number of major continuing projects in the State.

a/ Covers also Mysore.

b/ Covers also U.P. and Nepal.

c/ Covers also Rajasthan.

d/ Covers also Rajasthan.

* Projects included for detailed study.

20. The preceding analysis aimed at stratifying the 64 major continuing projects mainly into two groups viz., cost escalation group and revised cost estimate group. Cost escalation group was further subdivided into three groups: (a) high cost escalation (100 per cent or more cost rise), (b) medium cost escalation (cost rise between 50 and 99 per cent), and (c) low cost escalation (cost rise below 50 per cent). In a similar manner, revised cost estimate group was divided into three groups according to the size of the estimate: (a) Large projects (projects whose revised cost estimates exceed a sum of Rs. 100 crores), (b) Medium projects (projects whose revised cost estimates are between Rs. 51 crores and Rs. 100 crores), and (c) Small projects (projects whose revised cost estimates are Rs. 50 crores or below). There were 32 projects in the high cost escalation group, 16 projects in the medium cost escalation group and 16 projects in the low cost escalation group. Within the high cost escalation group there were 16 projects whose cost escalation came between 100 and 200 per cent, 8 whose cost escalation came between 201 and 300 per cent, 4 whose cost

escalation came between 301 and 400 per cent and only 4 whose cost escalation went beyond 401 per cent. Table 3 identifies these projects according to these ranges in the 'High Cost Escalation Group'. They covered 11 States of the Indian Union (see Table 2). In the highest cost escalation category, that is to say, where the cost escalation went beyond 401 per cent came only 3 States viz. Gujarat, Kerala and Mysore. The next group where the cost escalation ranged from 301 to 400 per cent covered 4 States viz. Bihar, Haryana, Kerala and Orissa. Thereafter we come to the group where the cost escalation ranged from 201 to 300 per cent. They covered 6 States viz. Gujarat, Kerala, Madhya Pradesh, Mysore, Orissa and Uttar Pradesh. The last category in the high cost escalation group covered projects whose cost escalation ranged from 100 to 200 per cent. They included 8 States viz. Andhra Pradesh, Bihar, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Mysore and Tamil Nadu.

21. There were 16 projects in the 'Medium Cost Escalation Group'. Within the 'Medium Cost Escalation Group' there were 5 projects whose cost escalation came between 50 and 70 per cent, 9 whose cost escalation came between 71 and 90 per cent and 2 whose cost escalation came between 91 and 99 per cent. Table 5 identifies the projects according to these ranges. They covered 9 States of the Indian Union (see Table 4). In the highest cost escalation category within this group, that is to say, where the cost escalation ranged between 91 and 99 per cent came only two States viz. Andhra Pradesh and Maharashtra. The next group where the cost escalation ranged from 71 to 90 per cent covered 6 States viz. Andhra Pradesh, Gujarat, Maharashtra, Punjab, Rajasthan and West Bengal. The last category in the 'Medium Cost Escalation Group' covered projects whose cost escalation ranged from 50 to 70 per cent. They included 4 States viz. Bihar, Haryana, Madhya Pradesh and Maharashtra.

22. Proceeding in the same manner we find that there were 16 projects in the 'Low Cost Escalation Group'. Within this group there were 6 projects whose cost escalation came between 30 and 49 per cent, 7 whose cost escalation came between 10 and 29 per cent and 3 whose cost escalation came below 10 per cent. Table 7 identifies the projects according to these ranges. They covered 10 States of the Indian Union (see Table 6). In the highest cost escalation category within this group, that is to say, where the cost escalation ranged between 30 and 49 per cent came 4 States viz. Andhra Pradesh, Maharashtra, Orissa and West Bengal. The next group where the cost escalation ranged between 10 and 29 per cent covered 5 States viz. Bihar, Gujarat, Maharashtra, Mysore and Punjab. The last category in the 'Low Cost Escalation Group' covered projects whose cost escalation ranged below 10 per cent. They included 3 States viz. Maharashtra, Tamil Nadu and Uttar Pradesh.

23. Table 8 gives the distribution of 64 major continuing projects with breakdowns by cost escalation groups: high, medium and low, and large, medium and small projects. Large projects have been defined as those projects whose revised cost estimates exceed Rs. 100 crores. Medium projects are defined as those projects whose cost estimates

between Rs. 51 crores and Rs. 100 crores. Small projects are those projects whose cost estimates are below Rs. 50 crores It will be seen that there are 10 projects whose revised cost estimates exceed Rs. 100 crores. They cover 7 States of the Indian Union (see Table 9). Among these 6 come under the high cost escalation category, 3 in the medium cost escalation category and 1 in the low cost escalation category. Table 10 gives in a similar manner the names of 10 projects which come under the medium category projects. In other words, these are projects whose revised cost estimate lie between Rs. 51 crores and Rs. 100 crores. Among these 3 come under the high cost escalation category, 4 in the medium cost escalation category and 3 in the low cost escalation category. Table 11 gives data about 44 small projects, that is to say, projects whose revised cost estimates are below Rs. 50 crores. Among these 23 come under the high cost escalation category, 9 under the medium cost escalation category and 12 in the low cost escalation category.

24. Since the Committee thought that the best way to draw a representative small sample from these 64 projects would be to give equal consideration to these two types of stratum viz. stratification by revised cost estimates and stratification by cost escalation, a sample of 6 projects was drawn, 3 from the large, 1 from the medium and 2 from the small cost group. Incidentally, they also covered 2 projects from the high cost escalation group and 4 projects from the medium cost escalation group. These 6 projects were taken up for detailed study.

# 3. THE APPROACH

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25. The Committee carefully considered the methodology that it should adopt for dealing with the task presented before it. There are issues involved here which require for its understanding knowledge of various technical disciplines. Even theoretical knowledge is not enough. This must be backed by practical experience. Planning, programming and execution of irrigation and multipurpose projects demand an integration of knowledge from various subjects such as hydraulics, hydrology, geology, topography, soil science, sedimentation, structural engineering, agriculture, social and economic statistics, econometrics, operations research, administration and even politics. Information had to be collected from men of experience in all these fields. The usual method of issuing questionnaire was resorted to.

26. In the first meeting of the Committee the members discussed at length the broad issues. This was facilitated by a comprehensive background paper prepared by the Member-Secretary. The paper discussed at length problems such as the existing arrangement for investigation of new projects. It raised questions as to whether new circles or divisions are set up for dealing with these assignments or existing maintenance or construction units carry on these activities in the States? Are they properly manned? Is there any sense of awareness for posting the right type of people for this kind of work? More precisely, are geologists and agricultural experts employed for preliminary investigations? If so, how are their services secured?

Are substantial provisions made in the project estimates for land compensation and rehabilitation of displaced persons? How are knowledge regarding rates of land and scales of rehabilitation measures gathered?

How does one determine the feasibility of a project? It is well known that the present criterion for judging the suitability of a project is on the basis of 'benefit-cost ratio'. The earlier criterion was based on the yield of a 'net revenue' after a reasonable period of development, usually ten years. This figure must be equal to the prevailing rate of interest or some prescribed figure considered as 'productive rate'. The question that is to be considered is that whether 'benefit-cost ratios' must be recomputed to judge the feasibility of the project in view of the distortion that takes place in this figure on account of changing price situation over a period of time. How are the data required for this computation collected? More precisely, how is this ratio calculated before the detailed investigation? How does this figure compare after the detailed investigation?

How are the prices of the various goods and services used in a construction project worked out? It is often found that the schedule of prices on which these are based go out of date. Whether there is any regular system to update these prices? Whether construction procedures are properly visualised while adopting the rates?

Are there any systems for recording construction costs and similar data for future use in the framing of new projects? More precisely, are data on output of construction recorded? Is there any record of fuel consumption? What is the hourly use rate of machinery and equipment? Are data on cost of construction of different types of canal structures maintained? These are broadly the questions which come in one's mind while formulating a water resources project.

27. In a similar manner, the Committee in its first meeting reviewed in general terms the reasons for the rise in the estimated costs of projects. One of the main reasons usually attributed is inadequate investigation. Insufficient geological exploration of the foundations of structures have been known to have caused very major changes in design leading to enhanced costs. Often data collection and analysis are inadequate to determine the hydrology of a project. The picture of water availability is completely changed as a consequence. Soil surveys are frequently not carried out properly. Crop patterns cannot be known in the absence of suitable soil survey. Water planning is not possible. Sometimes 'borrow area' (area from which some construction materials could be procured) investigations are not complete creating a factor of uncertainty in the determination of cost. Sometimes due to inadequate surveys the number of cross-drainage works and other structures in canals are not known. All these increase the area of uncertainty in the estimation of cost.

Changes in the 'scope' of the project are often introduced during the stage of execution in order to incorporate more benefits. Sometimes the area to be irrigated is increased. Sometimes more flood protection is afforded to the area. New structures are provided. Existing programme of work is increased.

Changes in 'designs' are often introduced after detailed investigations. They may give rise to cost. They are introduced to make adjustment for factors which might have undergone modification as a result of detailed study. However, sometimes they result in economy. More often they are introduced for reasons of safety.

Sometimes 'additional works' are subsequently provided in a project which neither contribute to increase in the 'scope' nor are justified by any considerations of detailed design. For example, sometimes large increases are made in the number of bridges and cattle crossings due to public demand during the execution of the project. There are cases in which the distribution system is not taken down to the scheduled 40 hectare block/one cusec level at the initial stage. Sometimes provision is made for these activities after the project is sanctioned. These lead to factors which give rise to cost.

The existing procedure of charging the maintenance cost of project facilities to the capital cost till such time as the project is completed to the last detail and the accounts are closed contribute to cost escalation. Its incidence is significant when the completion is delayed inordinately.

In case of flood control schemes, heavy costs on repairs or replacement works during construction time charged to capital cost contribute substantially to cost escalation of multipurpose projects.

Court awards for land compensation have often upset all calculations made in this regard in the project report. Land rates have shown significant rise during the last decade. In a similar manner, there has been phenomenal rise in the provision made for the rehabilitation of persons displaced as a result of the setting up of a water resources project. There is no standard laid down in this respect thus introducing once again an area of uncertainty in cost estimate.

Cost estimate for a project is made at a point of time on the basis of prices prevailing at the time of its preparation. No allowance is made in the estimate to cover the increase due to rise in the prices of material and equipment and wages of labour. This materially changes the cost of the project at completion.

28. The Committee in its first meeting also went through the problems of execution and management. It raised several questions. The first and foremost among these was the question of programming. More precisely, the question was raised as to whether a network or even a bar-chart was drawn for the detailed execution of each type of activity. What advance action was taken to secure men, material and machinery of appropriate quality and quantity at scheduled points of time?

29. Administrative procedures are so lengthy and cumbersome that they stand as impediments to economy and speedy execution of projects. More precisely, a Chief Engineer is not provided with sufficient financial powers. He has to turn to the Government or the Control Board even for comparatively petty items. Staff of appropriate quality and number cannot be obtained quickly in view of the lengthy processing through which one has to pass. Responsibilities are often allocated in the present system of administration without suitable delegation of powers.

30. Construction equipment and machinery as far as they are available within the country cannot be imported. This is to conserve our foreign exchange and to encourage Indian industry. However, this is also an element which gives rise to cost. For example, indigenous shovels and dumpers cost much more than the imported ones of comparable capacities. This is also true for power equipments such as turbines and generators. To cap this all, the delivery schedules of two or three concerns now producing these items in the country are long and irregular. This is one of the causes for the increase in cost of the water resources projects. It also contributed to delay.

31. Shortage of steel in the country was one of the main reasons which contributed to the delay in the execution of projects in recent years. There is

a great shortage of steel plates required for the construction of penstocks. Projects are planned without any assurance to the availability of strategic materials on which their execution depends. There have been shortages also in the supply of cement often due to the non-availability of wagons. Transport planning has not kept pace with project planning bringing about bottlenecks contributing to delay and cost escalation. In case of explosives also the flow has not been continuous.

32. Non-availability of funds at appropriate time was also one of the main causes for delay and cost escalation. Progress was stopped for inadequate funds. After the initial mobilisation of efforts bottlenecks arrived in this way. The project had to retain heavy establishment without adequate work. The delay in execution further adds to inflationary pressures.

33. There has been continuing growth of consciousness among the labour to secure enhanced rights and privileges. Labour agitations accordingly are frequent. This adversely affects the progress of work and increases the costs of projects.

34. There is dearth of good contractors specially for doing big jobs. Lack of competition encourages higher bids creating another factor which gives rise to costs. Contracts are often not drafted in clear, comprehensive and equitable terms. To cover up uncertainties, the contractors quote higher rates. To cap this all, there is a credit squeeze in the market. The contractor is not able to raise the capital he needs for his work. Even bank guarantee is difficult to obtain these days in view of long procedures introduced after the nationalisation of banks. This further encourages the contractor to quote higher rates for the project work.

35. The discussions in the first meeting pooled together the experience of the experts and focussed attention to the strategy for drafting a suitable questionnaire. After a number of exercises with the background material prepared by the Member-Secretary, a decision was reached on the final shape of the questionnaire [ See Appendix 3 ]. The experts felt that if the questionnaire seeks to collect all relevant material it must be sufficiently flexible. The procedure adopted by the Committee, no doubt, had certain disadvantages. For example, precise statistical studies are not possible from material collected through such questionnaires. But this was considered inevitable when one bears in mind the manner in which projects are formulated and programmes prepared for their execution.

In consultation with experts of several disciplines besides engineering, the Committee, after prolonged discussions, prepared a flexible questionnaire for sending out to selected projects. Such a questionnaire was issued on April 28, 1972 with the request that replies may be sent by May 31, 1972.

36. A scientific investigation into the causes leading to a large number of revisions in the project estimates involved not merely the identification of the reasons but also their quantification so that the role played by each, particularly the principal causes, in pushing up the cost could be understood to suggest any remedial measures. It was feared that the questionnaire would not bring them out clearly enough to be very helpful. Irrigation and multipurpose projects seek to harness the natural resources of the country for the benefit of man. In the

process, mighty rivers and lofty mountains have to be tackled. Such projects involve colossal amount of investigations all of which cannot be completed at the stage of submitting a feasibility report. No doubt, such projects require considerable flexibility in matters of decision. To understand these projects or more precisely, to understand the decisions taken at different stages of construction which had serious repercussions on the estimated costs, it was necessary to track them down by retracing the paths of development. The technique of sampling or more precisely the method of 'case study' appeared to be the only course for drawing valid statistical inference. The Committee, as such, decided to examine in detail a manageable number of project estimates.

Six projects were selected for detailed study as already mentioned in para 24, three large projects (viz. Ukai, Beas Unit I and Ramganga), one medium project (viz. Jayakwadi Stage I) and two small projects (viz. Kallada and Kangsabati) [See Appendix 4 ]. These were examined and analysed in a painstaking manner and supplemented by field studies and across-the-desk discussions with persons actually engaged in the construction of projects.

The members of the Committee visited Ramganga, Ukai and Beas Unit-I projects and discussed at length the various problems which the project officers experienced in executing their work. Meetings were held at the project sites. Comprehensive background papers analysing the causes of delay and cost escalation were circulated by the Member-Secretary in each meeting so that issues could be focussed and discussed in a business-like way. In some meetings the project authorities also prepared their own papers highlighting the points which they wanted to articulate. Across-the-desk discussions in all these meetings clarified many doubts. More work was done in the field trips as the members could then devote their whole time and attention to the subject. At the headquarters, the Committee drew upon the knowledge and experience of the senior engineers of the Central Water & Power Commission who brought with them a life-time's experience in planning and execution of water resources projects.

In short, through penetrating cost analyses, economic and statistical studies, detailed discussions with officers who had gained their knowledge by working in different parts of the country, across-the-desk discussions with officers who had actually executed projects in Gujarat, Uttar Pradesh and the Punjab, the Committee drew its basic material which was later put to scientific scrutiny for arriving at conclusions.

# 4. PLANNING PROCESS IN THE WATER RESOURCES SECTOR

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37. One of the basic terms of reference to the Committee is to review the existing arrangements for the formulation of irrigation and multipurpose projects The idea is to study the process from beginning to end with a view to identifying the problems. Proper suggestions for improvement can be made only when all aspects of the question are studied in their logical context.

38. There is no uniformity in the approach towards preparation of the project reports in the States. The patterns differ in detail. A very general one may be mentioned here. Preliminary studies and investigations for a project are carried out usually at the level of an Executive Engineer. In general, no separate circles or divisions are set up for the same. Senior and experienced engineers are so busy with their own routine work that there is hardly much time that they can spare for going into the details of such studies. When the report of preliminary studies are put up to his superiors, usually a Superintending Engineer, the matter gets for the first time a review at an experienced hand. In the light of the advice given, further studies are carried out. More data are collected. However, limits are set to the extent of investigation that could be done from considerations of cost. All alternative sites are considered. Estimates are made of the amount of water that would be available. Figures are worked out on a rough basis as to the area that would be benefited and the amount of power that could be generated. Some broad aspects of the structures and distributaries are given. A rough nature of the design is drawn out and a rough estimate prepared. With all these information the preliminary report goes to the Chief Engineer. He looks into the question of the over-all necessity of the project from the point of view of the benefits that it would bring to the State. He looks also at the cost aspect and considers whether funds would be available for such an enterprise. If he is satisfied on these broad issues, he examines the technical aspects in greater detail and if necessary, orders collection of further data and studies in depth. When this is completed, the stage arrives when the report is transformed into what is known as a 'feasibility report'. It is this report which is submitted by the Engineers to the State Government for consideration.

39. After the report has received the approval of the State Government, several copies of the report are sent to the Centre. Sets of report come to the Ministry of Finance, Planning Commission, Ministry of Irrigation & Power and the Central Water & Power Commission (C.W.& P.C.). Each one is supposed to look at the report from its own point of view before the comments are consolidated at the level of the Technical Advisory Committee which gives central approval to the project. The project report is examined in C.W.& P.C. in its

broad technical and economic aspects for determining its feasibility. The examination is principally based upon data presented in the project report and it is presumed naturally that the data furnished are accurate and have been collected reliably after carrying out detailed investigations and field surveys under the supervision of competent personnel. The scrutiny by C.W.& P.C. does not cover the examination of detailed designs and working drawings of individual components or works of the project in regard to their structural, hydrauli mechanical and electrical performance and safety, which is to be ensured by the project authority. The other agencies mainly depend on the scrutiny made by C.W.& P.C. even though they review the report from their own point of view.

40. The C.W.& P.C., for the purpose of determining the standard of scrutiny, has divided the reports of irrigation and multipurpose projects into three categories. They are:

i) Projects costing a sum of Rs.25 lakhs to Rs.50 lakhs (scrutiny on the basis of a simplified proforma).

ii) Projects costing a sum of Rs.50 lakhs to Rs.500 lakhs (scrutiny on the basis of a detailed proforma) (Till 1971, this was upto Rs.300 lakhs).

iii) Projects costing Rs.5 crores and above (scrutiny on the basis of a detailed report) (Till 1971, this was for Rs.3 crores and above).

Reports under the categories (i) and (ii) above are examined briefly. A few aspects are scrutinised at depth. They are: (a) Hydrology (b) Water availability (c) Water planning (d) Basic planning and utilisation and (e) Inter-State aspects of water planning.

41. There is an elaborate machinery for the examination of project reports in the C.W.& P.C. Project reports which cover programmes involving an expenditure of more than Rs.5 crores and which come under category (iii) mentioned in paragraph 40 pass through these procedures. There is a Directorate of Technical Examination in the C.W.& P.C. whose main task is to coordinate the examination of irrigation and multipurpose projects. This is done in consultation with a number of specialised Directorates within the C.W.& P.C. Projects which cost below Rs.5 crores are examined independently by this Directorate. On rare occasions quick consultations are made with specialised Directorates when specific issues require elucidation. Only certain broad aspects are examined by this Directorate when big projects costing more than 5 crores arrive in the C.W.& P.C. for scrutiny. These relate to (i) Basic planning (ii) Water planning (iii) Inter-State aspects of planning (iv) Basin-wise planning (v) Availability of water and (vi) Utilisation of water. While integrating the examination reports of various specialised Directorates, the Technical Examination Directorate tries to sort out internal inconsistencies It also processes the report through the Technical Advisory Committee, Ministry of Irrigation & Power and the Planning Commission. In addition to the above

activities, the Technical Examination Directorate examines Reports received from other agencies. They are:

i) Civil Engineering aspects of Hydro-Electric Projects received from the Power Wing of the Central Water & Power Commission.

ii) Water Supply projects received from the Ministry of Health and Ministry of Steel.

iii) Projects sponsored by the Ministry of Food & Agriculture under Rural Works Programme and by the Dandakarnaya Development Authority.

42. The Project Reports are distributed for scrutiny to the following agencies:-

1. Ministries

   1.1 Irrigation & Power for clearance from inter-State and international angles.

   1.2 Ministry of Finance (Technical Section) for financial clearance.

   1.3 Ministry of Agriculture (Water Management Division) for clearance from the point of view of agriculture requirements.

2. Directorates of the Central Water & Power Commission

   2.1 Hydrology: Availability of water and determination of maximum flood.

   2.2 Central Soils and Materials Research Station: Drainage, soil survey and transmission losses in consultation with the Ministry of Food & Agriculture.

   2.3 Water, Irrigation & Navigation: Cropping pattern, intensity of irrigation, delta, duty, transmission losses and water management in consultation with the Ministry of Agriculture. Benefit-cost ratio and financial returns in consultation with the Finance Officer.

   2.4 Flood Control & Drainage: Water logging and drainage in consultation with the Ministry of Agriculture.

2.5 **Designs**

2.51 Concrete and Masonrv Dams: Spillway, flood-routing and designs.

2.52 Gates: Gates details and designs.

2.53 Earth & Rockfill Dams: Designs.

2.54 Canals: Barrage and canals designs.

2.55 Hydel Civil Designs: Civil works of power plant, pumping stations, and their allied structures and tunnels.

2.6 Plant & Machinery: Requirement of construction equipment, plant planning and layout.

2.7 Technical Examination & Coordination (Power Wing): Multipurpose projects.

2.8 Rates & Costs: Rates and Costs of works alongwith the Ministry of Finance (Technical Section).

Comments are collected and coordinated in the Technical Examination Directorate. In most cases the usual procedures are not followed. For example, it is expected that the Irrigation and Power Department of a State process the Project Report through their Departments of Finance, Revenue, Agriculture and Statistics. This is usually not done. Various alternatives are neither investigated nor discussed along with their merits and economics. Justification for adopting a particular alternative is rarely given. Many important aspects of the projects are not dealt with in the reports in sufficient detail. More precisely, they relate to:-

i) Submergence, rehabilitation, compensation, etc.

ii) Design assumptions, criteria, data and investigations carried out.

iii) Geology of the foundations of various structures.

iv) Contour plans of the commanded area.

v) Discussions regarding ground water levels and possibilities of water-logging and arrangements for drainage.

vi) Soil surveys and suitability of soil for irrigation.

vii) Conjunctive use of ground water and surface water for optimum use of available waters.

viii) Transmission losses in canals.

43. The scrutiny of project reports at the Centre is sometimes delayed. The reasons are many. The project reports may not be complete in all respect and may lack in vital data and studies. These have to be pointed out to the States. The States have to carry out further necessary investigations and revise the reports and these have to be re-examined. A large number of agencies within the Central Water & Power Commission and certain concerned Central Ministries are involved in the examination process. Comments have to be received from all, reviewed and consolidated before they are furnished to the States. In certain cases, there is inordinate delay in the compliance of such comments by the States. Sometimes, the replies from States are incomplete which require further correspondence. The diversities are thrashed out in conferences with the project authorities. Each process consumes time. As already mentioned in the foregoing paragraph some of the schemes are received at the Centre before they are even cleared by the State Finance, Revenue and Agriculture Departments. Want of agreements on inter-State aspects of some projects among the States result in delays in their clearance.

44. Preparation of project reports with great care and after adequate investigations and studies will considerably help in their expeditious clearance by the Centre. For this purpose, the Central Water & Power Commission has recently finalised "Guidelines for investigation of major irrigation & hydro-electric projects" (see Appendix 7) and circulated them to the States. The States have also been requested to obtain prior clearance of the schemes from their Finance, Revenue and Agriculture Departments and also advised to settle inter-State issues at the State level before sending the schemes for scrutiny. The set up for technical examination of projects in the C.W.& P.C. also needs to be streamlined and suitably strengthened. It has also to be seen if examination of the same thing by two departments can be avoided.

# 5. DATA BASE FOR PROJECT REPORTS

## 5. DATA BASE FOR PROJECT REPORTS

45. Adequacy of relevant factual information should be a principal criterion for deciding the suitability of a project report for acceptance. In advanced countries inter-disciplinary committees are set up to look into the standards for basic data. Success in the conservation, use and development of water resources depends largely on knowledge and interpretation of relevant facts and conditions. Facts have to be used in an intelligently applied planning procedure. Although adequate data may not guarantee adequate plans, their lack may lead to faulty plans. Optimum development at minimum cost may not be possible if appropriate data are not marshalled for preparing a project report.

46. Adequacy of data can be determined only when those who use the data specify precisely what they need. The agencies that produce the data can examine the needs of the users and find out the extent to which they can meet these needs. Close cooperation between the data-collecting agencies and the resource developing agencies is essential. In order to determine adequacy the first requirement is to see that data are properly defined by both the user and the supplier. The procedure for meeting deficiencies consists in organising fresh programmes of data collection through census and surveys. In the United States, the resource developing agencies in collaboration with the basic data producing agencies and the Bureau of the Budget specify the kinds of data they require. From a statement of their priority needs, annual programmes of collection, analysis and interpretation are developed. The bureau of the Budget assists in the planning and coordination of these annual programmes. Among the agencies whose representatives are included in the Committee on Standards for Basic Data are: (i) U.S. Weather Bureau, (ii) U.S. Geological Survey, (iii) U.S. Forest Service, (iv) Soil Conservation Service, (v) U.S. Bureau of Public Roads, (vi) U.S. Public Health Service, (vii) Office of the Secretary of the Interior, (viii) Federal Power Commission, (ix) Bureau of Reclamation, (x) Corps of Engineers, and (xi) Tennesse Valley Authority. These committees appointed a number of sub-committees who helped the parent committees in their tasks. Similar machineries were suggested for India recently by the Central Water & Power Commission in their paper "Statistical Requirements for the Fifth Plan". It suggested the formation of an inter-ministerial task force to study the existing status of activities in the various organisations concerned with the development of statistics of water resources.

This group was to lay down a long term and short term programme for data collection and analysis. It was also to suggest steps that should be taken to augment staff and equipment of these organisations. In addition to this organisational machinery, the C.W.& P.C. paper suggested the creation of a National Water Data Bank with similar regional data centres. The idea is to preserve in magnetic tapes the necessary physical and socio-economic data for subsequent retrieval and analysis by computer.

47. Two types of data are essential for the preparation of a proper project report. They are: (i) Physical (including biological and chemical), and (ii) Socio-economic. The principal categories under these heads are given below:-

1. Physical

- 1.1 Hydrology

  - 1.11 Precipitation
  - 1.12 Evaporation and other meteorological data
  - 1.13 Surface water
  - 1.14 Ground water
  - 1.15 Soil moisture
  - 1.16 Chemical and sanitary quality of water

- 1.2 Sedimentation
- 1.3 Topography
- 1.4 Geology
- 1.5 Soils
- 1.6 Cadastral survey
- 1.7 Vegetation
- 1.8 Fish and wild life

2. Socio-economic

- 2.1 Aggregative data

  - 2.11 Population
  - 2.12 Income
  - 2.13 Employment
  - 2.14 Production

- 2.2 Sectoral data
  - 2.21 Agriculture
  - 2.22 Forestry
  - 2.23 Fishing and trapping
  - 2.24 Manufacturing
  - 2.25 Mining
  - 2.26 Power
  - 2.27 Water Supply
  - 2.28 Recreation
  - 2.29 Pollution

Engineers generally maintain that continuity in collection of basic data must be maintained for those items which fluctuate widely. They feel that changes in location and magnitude of current construction programmes should not influence this continuity. An over-all picture of the entire national territory in sufficient detail is necessary if one has to identify the areas which need intensive study for. planning. More precisely, there is a general feeling that there should be more stations for meteorological observation of climatological data. Similarly, there should be more stream-gauge stations. It is also considered necessary to have surveys of ground water in a more systematic manner. In particular, reliable data are required on rainfall infiltration rates for various types of geological formation, ground water recharge from other sources such as seepage from canals, ponds, tanks, etc., influent drainage from rivers and the return flow of irrigation water and loss due to evapo-transpiration and surface flow.

48. Certain data could be collected on a routine basis. They relate to data of a permanent nature. More precisely, these are such items as topography and geology. Topographic mapping is the science of measuring and depicting on maps the physical and cultural features of a place. They describe relief (the physical feature of the earth's surface), drainage (streams, marshes, lakes and oceans) and culture (man-made features, such as roads, railways, buildings, boundaries, place names, etc.). These are base maps. Most of the other types of maps are compiled from topographic maps. For example, these maps are used for plotting and analysing geologic, soil, hydrologic and other types of data. The Survey of India is responsible for all topographic surveys as well as special surveys for the production of maps. During the plan period, the Survey of India was mainly occupied with the surveys for development projects and its normal surveys for preparing 1" topo sheets for areas where they did not exist got less priority. Among the surveys it carried out for the water resources sector includes:-

(i) Reservoir surveys
(ii) Surveys for dam areas
(iii) Command area surveys
(iv) Irrigation surveys
(v) Surveys for water supply schemes
(vi) Cadastral surveys
(vii) Flood control surveys
(viii) Surveys for assessment of land
(ix) Soil conservation surveys
(x) Surveys of excavated sites
(xi) Surveys for central and state geological survey agencies

The Survey Priorities Committee, some years ago, decided to give the hignest priority to the work of the Ministry of Irrigation & Power alloting almost half of the survey potential available with the Survey of India to the work required for the development of water and power resources of the country.

Data collections are usually divided into several phases. In the case of topography, one must first have large-area coverage. Maps must show details for a general inventory of the area. This is usually done at 1" equal to 1 mile or one-half mile. It would be better if maps are available for the entire project area. However, in general, these are not available. Under such circumstances programmes must be initiated in such a manner that there is a close collaboration between the data collecting agency and the resource development agency. More precisely, priorities for work should be given to areas where information is needed most urgently. When plans, drawings, and specifications of projects are undertaken, a more intensive coverage is required. Here the scales vary from 1:24000 to 1:12000. Mapping at the smaller scale should normally be undertaken by the data collecting agency. The larger scale mapping is usually done by the development agencies. Intensive coverage maps cover a broad field of requirements ranging from a detailed investigation of a limited area to large-scale plans for construction projects. These are also prepared normally by the construction agencies at scales 1:12000 or larger. Maps prepared for project reports must be adequate. Maps must be available covering the watershed of operating projects. The knowledge of the character of the topography is an important factor in estimating stream flow.

49. Geological data provide information on the make-up of the earth's crust. They show the distribution of the solid rocks and the unconsolidated rocks. One needs information about loose bodies of sand, gravel and clay as much as one needs information about solid rocks. It is also important to know the structural relations of one rock body to another, their folds and faults or dislocations. One must also have information about the distribution of mineral deposits. The Geological Survey of India and the State Directorates of Mines and Geology provide these data. Geologic maps are the main sources of information on mineral resources, underground waters, construction materials, and foundation for engineering structure. Since water control structures such as dams, tunnels and canals are built on or under the surface of the earth, it is important to collect and accurately interpret geologic data. The planning of such structures requires knowledge as to the strength, durability, water-tightness and ease of excavation of the geologic materials that lie below them. Highways like dams are built on geological materials. These materials are also used for their construction. One must estimate accurately the amount of cut and fill required. It is also important to know whether the structures will slide after rain. One must also know as to whether the material removed from cuts will stand up when used as fill. Knowledge of the permeability of soils and rocks are required for the classification of land for agricultural development.

Although the first official geological map of the country was published (1" =64 miles) in 1877 and was revised in 1911 and 1932 (1" = 32 miles) covering also Burma, Afghanistan and Tibet, systematic geologic mapping on a scale 1" = 1 mile was started during the first five year plan. During the first five year plan this covered an area of about 32,000 square miles. Similar activities were carried out in the succeeding plan period. Mappings are carried out in scales less than 1" = 1 mile as well as on larger scales. The total area mapped up to the beginning of the first plan period on scale 1" = 1 mile was 3,63,310 sq. miles.

For a general coverage, geologic maps and subsurface sections must provide information on workable mineral deposits in the area. Their importance can be evaluated in studying the economic feasibility of the project. Geologic studies are also an integral part of investigations for ground water supply. These maps are usually produced on scale 1" = 1 mile. Geologic factors affecting designs, specifications and detailed planning of construction projects are usually studied by the geologists associated with the construction agency.

More detailed studies of individual mineral deposits and ground water sources are carried out at this stage. The scale of the map now depends on the scope of the project and the nature of geologic formations. At later stages, particular aspects of geologic formations are studied by the staff of the construction agency. There is not much scope for advanced studies on structural geology in Indian Universities. The expertise is built within the Geological Survey of India by actually associating young geologists with experienced staff who had worked with engineering problems. The training is mostly based on the level of work already done in India. In view of these, for more difficult construction projects involving knowledge of engineering geology of a mature character, India still has to draw upon the technical know-how from foreign countries.

50. Soil data are needed for the construction of water resources projects. Irrigation soil surveys are either pre-irrigation or post-irrigation. The purpose of the pre-irrigation soil survey is the following:-

i) Allocation of areas fit for cultivation as soon as water becomes available.

ii) Identification of lands which can be reclaimed and determination of the amount of water required for reclamation.

iii) Determination of the prospects of rise in water table and water-logging.

The objects of the post-irrigation soil survey are the following:-

i) To locate the areas that have already deteriorated or are in the process of deterioration.

ii) To formulate methods for the reclamation of deteriorated areas, and saving of those which are likely to deteriorate.

iii) To determine the type of drainage required for reclamation or prevention of deterioration.

For such surveys, the surface and sub-soil samples are analysed for their mechanical constituents, i.e. clay, silt, soluble salts and exchangeable bases. During the plan period, a number of soil surveys were carried out for the following purposes:

a) Irrigation
b) Waste and utilisation
c) Soil conservation

(d) Agronomic use
(e) Rehabilitation and reclamation
(f) General land use.

Collection and collation of soil data are mainly organised by the Indian Agricultural Research Institute. During the second five year plan period, soil correlation programme on an all-India basis was started in the four major soil regions of the country viz. alluvial, black, red and laterite. This involves classification and nomenclature of soils on a uniform basis and preparation of soil survey reports and soil maps. The work was planned in close consultation with the States to avoid duplication. The land utilisation survey scheme of the Central Soil Conservation Board was later integrated with this scheme. Standard soil surveys in the catchment areas of some of the major river valley projects were started during the second five year plan. This was done for classifying the soils and grouping them into capability classes for adoption of soil conservation measures to minimise soil erosion and to increase the life of the dams. The soil survey work in the catchment areas involves 30 to 40 per cent of detailed soil survey mainly in agricultural lands and reconnaissance soil survey in the rest of the areas. The work involves conducting of standard soil surveys and preparation of land use classification maps which could be used not only for planning and executing soil conservation practices in both agricultural and non-agricultural lands, but also covers surveys for rehabilitation, afforestation, irrigated agriculture, etc. During the period 1956-1962 about 3 million acres of the catchment areas of the river valley projects were surveyed. In addition, about 15 million acres were surveyed by the staff of the All India Soil and Land Use Survey by detailed reconnaissance surveys in other areas in the States. However, this is still a drop in the ocean. A lot more must be done before we are satisfied with the status of our soil data.

Not all the requisite data useful to engineers are generally shown on soil maps. This could be rectified by obtaining certain additional information on soil characteristics. They relate to such items as shearing strength, consolidation, compaction and plasticity. Greater coordination between agencies and groups interested in soils is needed. Such coordination will lead to better understanding of soil problems. Data on soil collected from various sources could be integrated and put to better use.

51. Data on Hydrology cover such items as precipitation, evaporation and other meteorological data, data on surface water, ground water, soil moisture and chemical and sanitary quality of water. Meteorological data such as data on rainfall, temperature, humidity, snowfall, etc. must be collected accurately on a continuing basis and stored in a manner so that they are readily available. Information on precipitation is the first requirement for resource estimation. Unlike data on topography and geology meteorological data undergo frequent change. As such accurate measurements and a long series of record are necessary. A broad review of the present status on the subject indicates that there is much room for

improvement. For example, there are various deficiencies in the rainfall data. More precisely, they are:

i) Recordings in the bulk of stations are done by part-time observers in the States over whom it is not possible to maintain effective supervision.

ii) Raingauges are not maintained properly.

iii) Compilations and despatches of monthly and annual data to the Indian Meteorological Department, Poona do not take place regularly and systematically.

iv) Statistical activities are not supervised always by trained statisticians of sufficient seniority.

All these introduce defect in the basic data which are often taken for granted as correct. The raingauges existing in the country at present can be grouped mainly into the following categories:-

a) Raingauges at meteorological observatories maintained and controlled by the Indian Meteorological Department.

b) Raingauges maintained by the State Governments functioning under the technical guidance of the Indian Meteorological Department.

c) Raingauges which have been set up to collect data for specific projects or purposes. (These are generally maintained by the separate authorities of the central or state governments such as irrigation and public works, agriculture and forest departments.)

d) Raingauges maintained by other quasi-official or non-official institutions such as local boards, municipalities and industries etc.

Raingauges under category (b) form the bulk of the total number of raingauges in the country. The existing rainfall registration procedure covers only raingauges maintained under (a) and (b) above. Official publications on rainfall data contain generally the data of only these raingauges. Compiled data from the States arrive in the office of the Deputy Director General of Observatory (Climatology and Geophysics) at Poona. They issue publications called Rainfall in India and Monthly Rainfall in India collecting material from similar publications from the State rainfall registration authorities. From time to time, the Indian Meteorological Department processes data and publishes them in their Memoirs. One such Memoir covers the period 1878-1940. The other covers the period 1901-1950. In these publications data are available for roughly 3,000 gauge stations covering the country's main meteorological divisions and sub-divisions. Only those stations are included for which data are available for at least 5 years during the period under study.

52. Although these are very convenient and handy sources of information, most project engineers neither have time nor interest to go into the sources and the methods of compilation critically. They take for granted the data and proceed with the analysis. Whenever data are presented for such a long period one cannot vouch for accuracy. Preliminary scrutiny on the basis of consistency and other checks must be made before the data for such a long period can be classified as acceptable. It is often forgotten that a small amount of good data are much better than a large amount of indifferent data. The time, money and energy invested in the analysis of huge data of doubtful accuracy could be saved if a project engineer first ascertains the quality of the data before rushing to analyse them. Critical evaluation of basic data and their analysis for specific ends are specialised tasks. These must be undertaken by professionally qualified and experienced statisticians. The Indian Meteorological Department do not employ senior statisticians in general for their statistical duties. Meteorologists or physicists are considered good enough for statistical tasks. This situation could have been tolerated a few years back when sufficient number of qualified statisticians were not available in the country. Almost all Indian Universities now provide courses in statistics. These are supplemented by professional institutions like the Indian Statistical Institute. In-service training in statistics is also arranged each year through different types of courses by the Central Statistical Organisation (Cabinet Secretariat). Existing officers in central and state governments can benefit by these courses. Until recently, water resources organisations in the states and the centre did not consider it necessary to utilise the services of professionally qualified economists and statisticians for the planning and execution of the projects. In advanced countries, these disciplines are inherent parts of planning and programming. If proper data and methodology for analysis are not used there could be serious mistakes in the estimation of water resources, determination of maximum floods, various problems of design and finally the selection of an appropriate project out of many alternatives on considerations of cost and benefit. The Central Water & Power Commission has already given a lead in this matter by creating a full-fledged Directorate of Statistics manned by officers of the Indian Statistical Service (ISS). Similar steps are desirable in central and state agencies concerned with the collection and analysis of statistical data for the water resources sector.

53. There are not enough stations of stream-flow data in India to enable broad studies on programmes of water resources development for the entire nation. The inventory of stream-flow data for the whole country is still in an incomplete state for lack of response from the state authorities in sending the information to the centre. Proper machineries were not set up to evaluate the

quality and quantity of the data. Measures to improve the accurate measurement, collection storage, retrieval & analysis of stream-flow data are not adequate. The Central Water & Power Commission has recently set up a Committee to review the status of data and suggest measures for improvement. Similar steps are necessary in the states. Data, after appropriate scrutiny must be maintained in magnetic tapes in the central and regional data banks for future retrieval and analysis through computer. Inventories of data so maintained in the data banks must be published for the benefit of research workers engaged in the task of regional and central planning of water resources. Programmes for the setting up of new stations for stream-flow measurement and activities in the field of statistical studies for resource estimation can be started only when the data status is known properly. It is a waste of national efforts if data collected in so painstaking a manner are not scrutinised immediately and put to appropriate analysis. Even the task of storage is not handled in a scientific manner. Realizing these shortcomings, the C.W.& P.C. has recently started programmes for setting up data banks. They have prepared mechanically across-classified directories of stream-flow data status and similar directories of medium and major water resources projects indicating the current information position on the subject.

54. Surface water and ground water are related fields. The programme for one requires a knowledge of the other. At present very little reliable information is available about the resources of ground water. Apart from data on rainfall, data are required on various types of hydrological formation, ground water recharge from sources such as see page from canals, ponds, tanks, etc., influent drainage from rivers and the return flow of irrigation water. No scientific assessment of ground water resources is possible unless proper investigations are made on these aspects. In the absence of data, crude assessments are made based on wild guesses. All those influence scientific project informulation. The Central Ground Water Board is at present engaged in applying itself to the task of filling up the data gap and improving resource estimation in the field of ground water. For ground water studies, statistical relationship of stream-flow with ground water recharge and discharge must be worked out. It is also necessary to have rainfall infiltration studies to estimate contribution of rainfall to ground water recharge. Similar studies are required for the estimation of seepage and recharge from canals, lakes, ponds etc. Studies are required on the geometry of aquifers leading to recharge and discharge of ground water. Finally mathematical models of the ground water system must be studied for the general problem of water balance.

55. Soil moisture data help in understanding the hydrologic cycle. A knowledge of soil moisture condition in the form of frost or liquid moisture will help to predict more accurately the amount of water which will percolate to ground water or will become surface flow. The moisture present in the soil at the time of flood-producing precipitation influences the quantity which becomes runoff. its study also helps to determine magnitude of water yields. The quantity of moisture lost from any soil by transpiration is determined by

the type and depth of root penetration of its vegetal cover. Under any particular climatic conditions, the vegetal cover and the soil determine the availability of soil moisture at any time. Studies on vegetal cover and soil moisture will help to predict water yields and flood flows. It will also help watershed management for runoff control. Very little data are available on this subject. Programmes should be developed for systematic studies on this subject.

The chemical quality of water is related to its suitability for use in industry, agriculture or domestic supply. Water resources agencies collect these data. The concentration of dissolved mineral matter determines their suitability for different purposes. The studies aim at determining the chemical properties and thereafter evaluating the data from the point of view of geology and hydrology. It is one of the duties of public authorities to prevent stream pollution and improve the sanitary quality of water needed for various uses, public water supply, propagation of fish and aquatic life, recreational, agricultural, industrial and other uses. The first step relates to a study of the effect of sewage and industrial waste discharge on the receiving stream. Data must be collected for each source of pollution. It will relate to flow, strength and character of the pollution and on the physical, chemical, bacteriological and other biological changes in the stream resulting from pollution. These data are used along with stream discharges and velocities, precipitation waste action, wind action, and other factors which influence the self purification capacity of the stream. Impurities in water can be divided into degradable waste which decomposes into harmless substances or are otherwise removed from the stream by natural biological, chemical or physical processes, and non-degradable wastes, which are not altered by such processes. The first class includes domestic sewage, heat, plant nutrients, most bacteria and viruses, and non-colloidal sediments. The second includes salts and other inorganic chemicals, radiological waste products, persistant organic chemicals including many detergents and agricultural chemicals, and colloidal suspensions. Contamination refers to impurities posing as hazard to human health. Sanitary engineering divisions of the State Departments of Public Health should be able to provide an inventory of sewage facilities. They could also arrange for annual data on flow and character of wastes, treatment applied, downstream water uses, effect of pollution on these uses, and corrective measures required. Industries must be made to participate in studies for obtaining data on industrial waste. Sample surveys could be carried out for each source of pollution.

56. Sediments in streams include important losses of soil from accelerated erosion of agricultural and range lands, from cutting of stream banks, and from erosion of stream beds. They also adversely affect the construction and operation of other hydraulic structures. Sediment in streams interferes with irrigation, navigation, highway and railway construction and maintenance, recreation, the utilisation of stream water for industrial and domestic supplies. It is also detrimental to fish and wildlife. Reliable data are required on the quantities and qualities of sediment transported by streams throughout the country. This information is required to take steps for controlling or retarding various forms of erosion. The data are used also for the development of river basins. Data collection programme should be given priority for river basins where the rate of sediment production is highest. Samples are collected from stations located at selected points on streams.

In most cases, sediment sampling stations are located at or near stream gauging stations. This is because discharge data are required concurrently for measuring sediment load. Data are required for daily, monthly and annual sedimentation loads. The present status of data is not satisfactory. More unsatisfactory is the status of their processing, storage and analysis. A good-deal of coordination is required in this sphere. The data obtained must be scrutinised first and classified according to their grades of suitability for further analysis. Areas where soil conservation programmes must be taken up immediately must be identified on the basis of these data. Echo-sounding methods are also used in addition to the method of collecting data on a spended load for studying sediment-load in the reservoirs. Proper integration of analysis is necessary for drawing valid conclusion from data already collected. The Central Water & Power Commission has taken certain steps in this connection in consultation with the Central Board of Irrigation & Power and the State authorities. However, much still remains to be done.

57. Data on vegetal cover are useful for watershed management, planning and operation. They indicate the kind of land treatment measures that must be used. They also give some broad clues for interpretation of items such as the rates of infiltration, permeability of the soil, need for drainage, character of soil for agricultural developments and the chemical nature of the soil. Associated with data on topography, they help to give information on the degree, the relative amount and character of erosion. They help to determine infiltration rates, runoff conditions and provide for land use programmes. They identify the location of actual and potential runoff, silt and sediment-producing areas. They also help to determine the extent of grazing that should be permitted by livestock or by big game. They identify the areas of abuse by overgrazing. They also help in segregating the zones which should be maintained as watershed protection area. Data in this field are also inadequate. A lot of area under forest have been surveyed on scale 4" = 1 mile. Some areas are still unclassified. Aerial surveys may be helpful for forests at high altitudes. The Ministry of Agriculture has to take steps to fill up data gaps in this field.

58. Planning for the development of water resources demands data covering fish and wildlife. They are needed where migratory fish are involved because development can block passage to spawning grounds. The developments may affect the food and nesting area of water fowl and migratory birds. They affect the habitats of various games and other forms of wildlife, in turn, may affect water developments. Quality of water and sedimentation may adversely affect shell-fish. Streams and lakes must be surveyed to provide information on habitat conditions suitable for fish, birds and mammals. One must have knowledge also of fish and wildlife population and ecology. Detailed information is required on population densities and trends for the various fish and wildlife species. Data are required on growth, recruitment, exploitation and natural mortality rates. Very little information is available on the number of people who fish and

hunt. Data on these fields must be collected on a continuing basis probably by sampling method in consultation and cooperation with the appropriate governmental agency. Techniques and procedures for biological surveys have not been perfected yet. The problems as to how to find alternate habitats for wildlife can be studied properly when necessary data are collected. Efforts should be made to initiate programmes of data collection for fish, fowl and wildlife.

59. When we turn from physical data to socio-economic data we find the situation is much better. These are basic data required for economic and social planning and as such a good deal of attention has been focussed for their improvement. For a 'general coverage' in project reports data are needed to provide a financial and social basis for project justification. The amount and kind of data required as well as the priorities to be assigned to items depend upon the nature of the project. Data on population, price and costs are required for all types of projects.

At the stage of planning, data for irrigation projects are required for the following items:-

i) Population (Number, location, density; Age, sex, race and size of family; Income and expenditure)

ii) Resources (Land, water and mineral)

iii) Agriculture (Production, sales etc.)

iv) Power

v) Price.

At the stage of planning, data for hydro-electric projects are required for the following items:-

i) Population (Number, location, density; Age, sex, race and size of family; Income and expenditure)

ii) Resources (Land, water and mineral)

iii) Mining (Production, sales etc.)

iv) Manufacturing (Production, sales etc.)

v) Power

vi) Price.

At the stage of planning, data for flood control and drainage projects are required for the following items:-

i) Population (Number, location and density)
ii) Resources (Land, water and mineral)
iii) Agricultural (Production)
iv) Mineral (Production)
v) Other production
vi) Damages
vii) Price.

At the stage of planning, data for water supply projects are required for the following items:-

i) Population (Number, location, density; Age, sex, race and size of family; Income and expenditure)
ii) Resources (Water, mineral)
iii) Mining (Production, sales)
iv) Manufacturing (Production, sales)
v) Other production
vi) Price.

60. For proper water resources planning, it is necessary to know the needs of the people in the river basin. For this, data are required on population, production, employment and income and their projection to a future date. To determine the adequacy of data, it is necessary to consider the type of data needed, purpose for which they are used, the amount of detail that is required and the time when they must be made available. At the first sight one may feel that all basic socio-economic data bearing directly or indirectly upon water resources development must be collected and made available. However, this is neither essential nor justifiable. In most cases, it may not be practicable to collect more data in this sphere than those that are already being collected by existing governmental agencies. The deficiencies usually relate to their availability with sufficient geographical

and time breakdowns. At the stage of investigation more details are required of certain types of data which are usually not available in the routine surveys. Data are first required for an over-all study of the region of which the watershed is a part.

Water requirements for the future demand an economic picture of the community in terms of population (age, sex, race and size of family; number, location and density; income and expenditure) labour force and employment (annual figures with breakdowns by districts and industry groups), income (with breakdowns by districts, sources of income and if possible distribution of income) and, production (with breakdowns by districts, sales, investment, principal input and outputs). Some of the important data required for functional studies include: (a) Food requirements under given diet standards compared to the land available; (b) Trend of food production and factors which are likely to affect them; (c) Land resource survey and their future trend in the light of developments introduced and planned for the future such as flood control, drainage, clearing, and irrigation; (d) Data (cost and benefits) on programmes of improvement to increase production vis-a-vis bringing in new areas; (e) Agricultural costs and price and their relation to farm production; (f) Alternative sources of supply of agricultural products as between major regions of the country. In addition to the above-mentioned basis data, data are required on ownership outside farm, crop rotation, methods and cost of land improvement and agricultural prices. By sectors, data are required for (a) Forestry: A complete inventory and time to time survey to keep the inventory up-to-date. (b) Fishing: Data are required on the quantities and value of fish taken, fishery products, number of fishermen, vessels and items of equipment. Data are required by river basin in order to study the effect of project development on fishing industry. (c) Manufacturing: Source and use of water by types of industry and their cost relating them to size of the unit as measured by investment, employment and output. Projections are also required if necessary by the use of sampling methods in addition to census techniques. (d) Mining: Same type of data are required as in the case of manufactures to determine the demand for water for the mining industry. Data on amounts and value of minerals are of use in transportation studies (involving navigation), in flood control and hydro-power investigations where the mining properties may be affected by the improvements. (e) Power: Factors that effect the demand for power; present and estimated future power requirements, present power supply, the need for additional generating capacity, and the value of power. Breakdowns by smaller geographical area, time and finer industrial categories within the present groupings of commercial, agricultural, non-agricultural, industrial, residential etc. are required. (f) Flood Damage: Data on damages caused by floods are useful for consideration of flood control projects. They are also necessary for designing structures which may be subject to flood damage. Data used for project benefit determination are usually scanty. In some cases, it may be necessary to initiate sample surveys of a more intensive nature to fill up data-gaps. (g) Water Supply: Water required by the industry and people for their domestic use in future must be projected with the help of over-all base data. Changed trends in water consumption must be taken into consideration for making future projections. (h) Navigation: More data are required on traffic (including freights) carried, cost of transportation, rates, origin destination information to determine the cost benefit ratio of navigation facilities more accurately. (i) Pollution abatement: Direct and indirect damage from pollution must be estimated and benefits from their abatement evaluated to determine the feasibility of a pollution abatement project. (j) Recreation: Very little studies have been made in this field. More data are required to establish the value of recreational pursuits in terms of increased tourist expenditures. Statistics in these fields must be standarised by appropriate surveys. Data on attendance must be converted into per-capita monetary benefits. Recreational features include activities which require direct use of water such as boating, swimming and fishing. Shoreline activities do not use the water directly. Proximity to water enhances the value of certain activities such as picnicking, camping, and hiking. Expanding facilities for modern transportation and increasing income will lead to the use of reservoirs for recreation, a factor which planners must bear in mind. (k) Fish and Wildlife: It is necessary to make an appraisal of the cost and value of protecting these resources from commercial, recreational, and purely aesthetic points of view in connection with planning of water resources projects.

61. In view of these deficiencies, it is important that immediate steps be taken:-

(a) to set up a standing committee for the development of basic data required for planning water resources projects; such a committee must establish liaison with appropriate governmental agencies engaged in the development of data; the committee must prepare annual programmes for data collection and analysis;

(b) to set up a minimum standard for factual information which a project report must meet before it can be considered for acceptance;

(c) to see that researches are continued to improve techniques of data analysis; programme of in-service training to impart recent technical know-how in this subject must also be developed;

(d) in subject matter fields, steps should be taken to improve data status:-

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| (i) | Hydrology: | More raingauge and evaporation recording stations; scrutiny and analysis of existing data through computor; more surface water gauging stations; temperature recordings at these stations to be increased; more intensive ground water survey; more observation wells; more samples for analysis of chemical and sanitary quality of water; |
| (ii) | Sedimentation: | More stations for sampling of sedimentation loads; more survey of reservoirs; scrutiny and analysis of existing data; |

| | | |
|---|---|---|
| iii) | Topography: | An annual programme of adequate magnitude for topographic mapping must be prepared; topographic mapping of critical areas must be completed first; maps must be updated from time to time; |
| iv) | Geology: | The country must be covered by standard geological maps showing surface as well as structural geology for water resources development. Certain time target may be specified for the purpose; |
| v) | Soils: | Nation-wise soil classification and mapping must be completed within a certain period depending upon the resources; more coordination of activities between the agricultural and engineering departments, cadastral surveys must be completed as early as possible; |
| vi) | Vegetation: | Forest surveys must be completed within a reasonable period; |
| vii) | **Fish** and wildlife: | Information on population, trends and densities of fish and wildlife species must be collected; |
| viii) | Socio-economic: | Such data on population, means of livelihood, transportation, trade, industrial production, power and flood damages not regularly collected by existing agencies must be covered; necessary geographic and time breakdowns must be obtained; necessary data on agriculture may be obtained through the National Sample Survey Organisation (Cabinet Secretariat); Similar data on industry and mining through surveys carried out by the Central Statistical Organisation and the Indian Bureau of Mines; data on recreation should be collected through surveys to be conducted by the Department |

of tourism; data on domestic and industrial water supply must also be collected through appropriate agencies; data on water pollution must be collected through the Department of Health and special surveys; effect of land management on watershed hydrology must also be studied;

e) to set up national and regional water data banks for the storage, retrieval and analysis of data collected by various agencies.

# 6. BENEFIT COST CONCEPTS AND THEIR MEASUREMENT

## 6. BENEFIT COST CONCEPTS AND THEIR MEASUREMENT

62. A project must pass through a number of feasibility tests before it can be accepted for execution. The test of engineering feasibility is passed if the proposed project is capable of performing the function for which it was designed. Engineering design is confined to the technologically feasible region. A project passes through the monetary feasibility test if funds could be raised for its construction and operation. It passes through the political feasibility test if the necessary political approval could be secured. The test of social feasibility is passed if majority of the future users respond favourably to the project proposal. Economic feasibility consists in examining the total benefits that result from the project and finding out whether it would exceed those which would occur without the project by an amount in excess of the project cost. Economic feasibility depends on engineering feasibility which assures the benefit. Monetary feasibility need not go with economic feasibility. A project could be economically infeasible but monetarily feasible. This is because some interests are there to arrange the necessary funds for the construction of the project. However, since public funds are used for the construction of water resources projects, people must see that monetary feasibility is contingent on economic feasibility. Ordinarily, political support follows when economic and engineering feasibilities are assured. Sometimes, however, public pressure for project construction may be even stronger than considerations of economic feasibility.

Political feasibility is determined by analysing how key decision makers assess the favourable and adverse aspects of the projects. More specifically, this is found out by the intensity of popular feelings and the project potential for obtaining public support. Social feasibility is determined by assessing the impact of the project on the daily lives of majority of population in the area and finding out whether the people will go for the benefit. Engineering feasibility is ascertained through design analysis as described in Engineering texts. Monetary feasibility is determined by examining potential sources of available funds. Economic feasibility is based on the criterion of benefit-cost analysis.

63. Prior to 1964 the acceptability of a project depended on the rate of return earned by it. Although in 1964 CW&PC issued instructions to all State Governments to work out Benefit-Cost ratios for projects having a return of

less than 4.5% per annum (at the end of 10th year after completion), it was only in 1966 that the Government of India, Ministry of Irrigation & Power laid down that, as a general rule, a project should be considered worthwhile only if the B.C. ratio is not less than 1.5. It was further stated that exceptional cases such as those for scarcity and backward areas may, however, continue to receive special consideration. In this connection it may not be out of place to recall in brief in the following lines the background history leading to the acceptance of the benefit-cost ratio criterion by the Government for judging the feasibility of the project.

> "In 1958, the Planning Commission initiated studies of five major, well-established irrigation projects, namely, the Sarda Canal, the Gang Canal, the Tribeni Canal, the Damodar Canal and the Cauvery Mettur project. The aim was to assess the overall benefits and to find a better criterion for deciding whether various irrigation projects ought to be undertaken. These studies guided by a Committee of Direction headed by Prof. D. R. Gadgil were completed in 1961 and showed that large benefits accrued from irrigation in terms of double cropping, diversification and better quality crops, higher yields, larger income and greater employment opportunities for hired labour. Indirect benefits were the establishment of processing industries, the expansion of consumer industries, retail trade, and transport and communications. It became clear that the total benefits from irrigation were far larger than the direct financial returns accruing to Government from irrigation rates. The Committee, therefore, recommended that in future the benefit-cost ratio should be used for assessing the feasibility of new project instead of the traditional criterion of the direct financial return to Government." 1/

The planning Commission at its meeting held in October, 1964 considered the above mentioned report of the Gadgil Committee entitled "Criteria for appraising the feasibility of Irrigation Projects" and approved the principal recommendation of the Committee viz. that the benefit-cost ratio should be adopted as the criterion for judging irrigation projects. Again,

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1/ From the Report of Irrigation Commission, 1972 constituted by the Ministry of Irrigation & Power.

> "in 1964, the Committee to suggest Ways and Means of Improving Financial Returns from Irrigation Projects recommended that the economic benefit criterion should be adopted for sanctioning irrigation projects, instead of the financial criterion. The Government accepted this recommendation and the benefit-cost ratio criterion has since been in use." 1/

The introduction of the criterion of benefit-cost analysis in the decision making machinery of Government is one of the major accomplishments of Government programme in Water Resources Development.

## B.C. Ratio - Some Measurement Concepts

64. Benefits and costs occur due to various kinds of effects. There are categories of various types of 'pecuniary and social, non-transfer and transfer, on-site and off-site, direct and indirect, market and extra-market, economic and non-economic, measurable and non-measurable, monetary and non-monetary, tangible and intangible, direct and spillover, individual and collective, primary and secondary'. The distinctions among these categories vary among practical economists. It is necessary to use consistent terminologies for these items. They must be classified systematically. It is important to concentrate on the concepts behind each terminology. Results of economic analysis are expressed usually in terms of a single figure. Gross benefits are placed in the numerator and costs are placed in the denominator. The project passes the economic feasibility test if this ratio exceeds one. Net benefit is defined as the numerator less the denominator. The project is justified if the net benefit is positive. The numerator contains a figure which is the algebraic effects to private parties. The denominator contains a figure which is the sum of all public financial costs including initial construction and subsequent upkeep. What is required is that benefits must exceed cost or that the ratio exceeds one. However, as has already been stated the Government has laid down that as a general rule, a project should be considered worthwhile only if this ratio is not less than 1.5 except in scarcity and backward areas.

## Benefits

65. Benefits attributable to a project are expressed by the difference in the economy of a project area "with" or "without" irrigation. "Primary

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From the Report of Irrigation Commission, 1972 constituted by the Ministry of Irrigation & Power.

benefits are the value of the immediate products or services resulting from the measure for which project costs and associated costs were incurred." 2/ The creation of a large production unit such as a water resources project brings about additional activities in the manufacturing, transportation and public utilities sector. Many of these economies are known as secondary benefits.

> "It is recognised that the measurement of benefits and costs at the primary level is easier and can be fairly precise while that at the secondary, tertiary, etc., levels, it becomes progressively difficult and imprecise. A distinction is also drawn between tangible and intangible benefits and it is conceded that the measurement of the latter is very difficult if not impossible. It is true that the calculations of benefit-cost ratios require much comprehensive data regarding agriculture both under dry and irrigated conditions. Such data, at present are somewhat inadequately available in India but they do exist in sufficient volume to be used for workable beginning in this direction. The data are, moreover, progressively becoming available in greater volume and coverage. It is partly to meet this inadequacy that we have recommended that only primary direct benefits and costs related to the projects should be taken into account." 2/

66. The specific factors relevant to the estimation of primary benefits and costs have been laid down as -

Benefits

i) Agricultural production in the area to be irrigated by the project before or without the project,

ii) Agricultural production in the area after or with irrigation, and

iii) The prices to be used for converting (i) and (ii) into monetary terms.

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2/ From the Report on Criteria for Appraising the Feasibility of Irrigation Projects - Research Programmes Committee, Planning Commission, 1965, subsequently referred to as "Criteria Report" in this chapter.

## Costs

i) Project costs,

ii) Associated costs, and

iii) Prices to be used for estimating costs.

67. Project costs include all monetary expenses incurred by the Government/investment authority for the installation and operation of the project together with such related expenditure on auxiliary facilities e.g., distribution and drainage network, approach roads, recreational structures, etc. The main items of project costs reduced to equivalent annual charges are:

i) Interest,

ii) Depreciation, and

iii) Operation and maintenance charges.

68. In working out the benefit-cost ratios the Criteria Report has adopted two alternative bases viz. 5% and 10% interest on capital outlay. The former conforms to the prevailing productivity rate whereas the latter is adopted mainly as a necessity (for an underdeveloped country with real scarcity of capital) and partly to provide for the risk factor arising from uncertainties of accrual of benefits through the life of the project. As per the prevailing practice the State Governments indicate the Benefit-cost ratio by taking into account both these bases while the actual feasibility is judged on the basis of 10% interest on capital.

## Depreciation

69. The Criteria Report has recommended that depreciation should be calculated on the maximum life of project assumed as 100 years except where the physical life of a project is actually estimated to be less.

## Operation and Maintenance Charges

70. Working and administration of irrigation projects involve the employment of considerable establishment. In addition to distribution of supplies, separate revenue staff has to be maintained in order to assess the area for

purposes of levying water rates. In addition, certain amount of maintenance is required in order to repair any damage that may occur during the year due to traffic, cattle and other natural causes, that is, rain, wind, etc. Another factor which adds to the annual maintenance charges is silt, which has to be cleared from channels from time to time. Besides, there is expenditure on minor improvements which is also generally charged to maintenance.

The maintenance charges vary from State to State. Realising that some uniform rate should be applied for calculation of benefit-cost ratio the Criteria Report recommended that a rate of Rs.3 per acre be adopted for the projects in South-Eastern States of Madras, Mysore, Andhra Pradesh & Orissa, and a rate of Rs.4 per acre in others.

In addition, for operation and maintenance of dams, the report suggested a uniform rate of 1% of capital outlay for adoption.

71. Associated costs include the additional expenses that the farmer will have to incur to realise the benefits of irrigation. The associated costs are deduct items from gross benefits attributable to a project. These include the costs of (1) seed, (2) manure, (3) rent paid on land taken on lease from which land revenue to be paid by the owner, if any, is deducted, (4) charge due to land revenue, (5) repairs and depreciation on implements, (6) hire charges of bullock labour and maintenance charges of owned bullocks, and (7) hire charges of human labour. These costs together form that portion of the total cost which the cultivator has to meet by paying out in cash or kind.

In irrigated agriculture one more item of cost will have to be included when irrigation newly comes to a region, viz. (8) capital cost of preparing land for irrigation.

72. As only 'primary' benefits are considered in working out the benefit-cost ratio, the estimation of 'secondary' costs are excluded. Secondary costs are the values of any goods and services (other than those covered by project and associated costs) which are used as a result of the project. These can be categorised as costs of transporting the produce, milling costs, bakery costs, costs of distribution to the consumers, etc. Where intangible effects or negative benefits, however, are considered important, the project proposals would indicate these in qualitative terms.

## Price Level

73. The assumption of price level is crucial to estimation of benefits and costs. Ideally, estimates of benefits and costs should reflect price

relationships prevailing at the time of occurrence of costs and benefits. The Criteria Report has recommended the use of average prices of preceding 5 years. Where, however, data are not available an average over shorter period could be used.

Availability of Data

74. A lot of information and data are required for a proper analysis of the benefits and costs. As for benefits, the information will relate to the area irrigated, the crop pattern before and after irrigation, yield of crops, intensity of irrigation or duty output and input of crops etc. The eight major items of inputs have already been indicated under the associated cost. The outputs are generally in the nature of the value of produce including fodder and cowdung. The Criteria Report mentions the project report as the source of availability for information on area irrigated, intensity of irrigation and to a certain extent crop pattern. The inputs and outputs will have to be estimated from farm business and/or cost accounting surveys of comparable areas within the irrigation command and outside. As to the capital costs of projects and their operation, while the former is available right from the project report, the latter has to be found from the Accountant Generals and the Departments of Irrigation of the various States.

Application of Data

75. With a view to assessing how for the instructions of the Government have been actually followed in working out the B.C. ratios in projects, the Committee examined some of the project reports as well as the replies received from the selected projects to whom the questionnaire was sent.

76. The Criteria Report recommends adoption of average prices of preceding 5 years or failing this the average of a shorter period. It is found that inspite of the lapse of nearly 5 to 6 years between the preparation of the original estimate and the revised estimate, the prices adopted for inputs and outputs have in some cases not been changed.

77. It has been laid down in the Criteria Report that to work out the annual depreciation of the capital investment the maximum life of a project may be assumed as 100 years, except in case where the life adopted is actually less than this. In the illustrations given in the Criteria Report for Bor and Nalganga projects the depreciation has been taken at 2% per annum which would indicate that the life of the projects assumed was 50 years. The project reports, however, indicate the life assumed as 75 years. Most of the project reports examined indicate adoption of 1% depreciation in working out the B.C. ratios. It is understood that in accepting this ratio, Ministry of Finance (Technical Section) insist on adoption of depreciation at 2% per annum.

78. As regards operation and maintenance charges it has been observed that although the Criteria Report recommends a rate of Rs. 3.00 per acre of irrigated area for adoption in the south-eastern States and Rs. 4.00 per acre for others, in its own illustrations, it has taken a figure of Rs. 10.00 per acre indicating that this was purely notional. In the project reports, however, it is found that there is near unanimity of adoption of Rs. 10.00 per acre on account of operation and maintenance. It is also understood that this figure is accepted by the Ministry of Finance (Technical Section). It is not clear how this figure could become a standard for most of the States and why they did not work out the actual averages obtained on this account from year to year.

It is found that the Central Water & Power Commission publishes the statistics concerning area irrigated and working expenses on irrigation works in the form of Financial Statements of Irrigation Works in India. These are based on the data received through the kind courtesies of the Accountant Generals and Departments of Irrigation of the various States. The publication cautions that the data reproduced have their limitations because the working expenses and receipts etc. pertain to the year in which the monetary transactions actually took place and not the legitimately fiscal year to which they may be strictly allocable. The Financial Statements have brought out information upto the year 1966-67. A study of the working expenses incurred during the three years 1964-65, 1965-66 and 1966-67 showed that considering both productive and unproductive works together, the average for the three years varies from State to State ranging from as low a figure as about Rs. 3.00 per acre to as high as about Rs. 20.00 per acre. This is also corroborated from the working expenses given for the years 1965-66 and 1966-67 in the Fifth Finance Commission Report, 1969 (which does not give the statistics of area irrigated in the States). Even with their limitations, these statistics highlight the basic fact that there is large variation from State to State in the operation and maintenance cost per unit area of irrigation. Under the circumstance it would be desirable that such figures are compiled and taken on a proper basis so that a realistic B.C. ratio is worked out.

79. In addition to the per acre cost of operation and administration, the Criteria Report suggests that for operation and maintenance of dams, a uniform rate of 1% of the capital outlay may be adopted. In its own examples this has not been taken into account. It is also found that such a charge has not been separately indicated in the project reports.

80. The Criteria Report lays down that when irrigation newly comes to a region some cost on account of preparing the land initially for irrigation has to be provided. It is, however, found that in the examples cited by it no such charge has been considered. It is also found from the study of the project reports that very few projects have taken this development cost in their calculations.

81. The Committee observed that in one project the upward revision of the estimated cost has brought down the B.C. ratio from 2.4 to 1.4 bringing it to the

category of economically unacceptable projects. This is inspite of the fact that higher crop yields as indicated by the Statistical Department have been reckoned in the revised report instead of those given by the Agriculture Department and adopted earlier. If the figures for crop yields given by the Agriculture Department are taken in the revised report, the economic viability would be totally lost as the B.C. ratio in that case would go below one.

## Conclusions

82. The Irrigation Commission 1972 has, in its report, mentioned that the benefit-cost ratio criterion 'is not only simpler, but is also widely used in most countries, particularly in the ECAFE region'. The Committee feels, in consonance with the Irrigation Commission, that this should continue to be used for judging the economic feasibility of irrigation projects.

The Committee, however, observed that there is a big gap between the procedure laid down in the Criteria Report and the methodology followed in working out the benefit-cost ratio. It is understood that while accepting this criterion in 1964, the Planning Commission, in pursuance of the suggestion made in the Criteria Report, constituted a Working Group consisting of irrigation experts, economists and planners for preparing a manual of standard procedures and methods for working out the benefit-cost ratio. It is further understood that a draft manual so prepared in 1969 was circulated to concerned Central Ministries and the State Governments for eliciting comments and suggestions, and only a few replies have been received so far. The Committee suggests that while framing the Manual, the Planning Commission may go into the question of the procedure for assessment of benefits in depth and indicate clearly the data which will be required to be collected for the purpose of working out the benefits and costs, illustrating at the same time the methodology to be followed step by step in arriving at the benefit-cost ratio. The cost of developing land for irrigation when it newly comes to a region may be appreciable and should not be missed in working out the B.C. ratio.

83. It has been observed that not much attention is paid in collecting up-to-date data for working out the B.C. ratio viz. cost of inputs like seed, manure, implements, land revenue, and hire charges of labour, bullocks, etc.; value of outputs viz. produce, fodder, cowdung, etc.; and operation and maintenance charges of irrigation projects. The quality of data is not considered and whatever are handy are adopted for the purpose.

It is suggested that State Governments should make a more thorough arrangement for collection and maintenance of the data required so that old and out-of-date figures are not used in working out the B.C. ratio.

84. The Criteria Report says that data regarding irrigated area and intensity of irrigation would be available from the project reports. The reliability of these data will depend on how they have been collected and used. The Committee, in course of its examination of the revised project estimates, has found that substantial changes have taken place in the revised reports due to inadequate investigations at the early stage. Such changes covered hydrology as well as irrigable area. Moreover the costs of projects have gone up in the revised estimates disproportionately to the increase in benefits and at least in one case this has upset the economic viability of the project. It is also observed, as explained in the earlier paragraphs, that the work of collection, compilation and adoption of data required for working out the B.C. ratios is not in a very good shape. Under the circumstance, the benefit-Cost ratios worked out at the feasibility report stage cannot be considered to be very representative. This would improve only when there is all round improvement in the preparation of estimates and collection and utilisation of proper data for the purpose.

85. The benefit-cost criterion for appraisal of irrigation projects is now in vogue for the last about eight years. It is necessary to see how it works out with the projects completed and compares with the one assessed at the formulation stage of the project. With the short time at its disposal, the Committee could not go into such details. It recommends that there should be someone like the area development authority in every State who should be responsible to watch continuously all the developments brought by irrigation so as to maintain an integrated view of the area. The Committee further recommends that in every State socio-economic studies for evaluation of benefits derived from the projects after completion should be taken up and done periodically by suitable agencies in association with the planning departments, universities, etc. This would help in framing future policies to effect further improvements.

# 7. DYNAMICS OF PROJECT ESTIMATES

## 7. DYNAMICS OF PROJECT ESTIMATES

### Some Conceptual Issues

86. Whenever there is a substantial revision in the original estimate of a project, many thoughts appear in public mind. The most common opinion that circulates and sometimes highly exaggerated is that there is wide-spread mismanagement and corruption. Criticism is voiced that projects are not properly conceived and formulated. One hears about projects being planned and executed which are not economically viable. There is also a feeling that project costs are deliberately under-estimated with boosted up benefit-cost ratios with the object of getting the project through. It is alleged that project planning and formulation is a product of technical manoeuvring; pressures and influences. That the above criticism is valid to a varying degree in some cases cannot be denied. However, such sweeping and blanket criticism resulting from increases in project costs, which are occasionally huge, is perhaps not warranted. It stems from inadequate appreciation of the procedures involved in the framing of project estimates and the factors which are responsible for cost escalation. For viewing the entire problem in its proper perspective, the Committee feels that it is essential to examine certain broad conceptual issues before investigating systematically the reasons for rise in the costs of projects.

87. Cost estimates of projects are drawn up on the basis of prices prevailing at the time of preparation of the project report. In such a convention the idea is inherent that the price line will generally be maintained and the estimate will not be thrown out by any material rise in the prices of commodities during the period of construction. During the First Five Year Plan period there was a stability of prices. In fact the rise in wholesale prices was mild upto 1962-63. However, the annual rate of rise during 1963-66 as indicated in the Planning Commission's Fourth Plan Mid-term Appraisal went up to 9%. Things went haywire in 1966-67 and 1967-68 when this jumped to 16% and then came down to 11%. But how did all this happen?

It would be unnecessary to dwell exhaustively on the causes of inflation about which the economists and planners are fully aware. Because of the teething problems of a developing economy and the radical political and social changes, stability of prices could not be achieved and inflation resulted. Inspite of efforts directed towards the growth of agricultural and industrial production, sufficient headway has not been made so far. As long as population is growing at the present rate and commodity production is not progressing at the rate desired, prices are bound to go up. Again, India is primarily an agricultural country. Our economic well being mainly depends on monsoon which is an unpredictable factor. Inflation also depends on that, everything else remaining same. During the last decade there was a severe drought in the country. The position was further aggravated by the fact that the country had to defend itself thrice from external aggression and face the aftermath of these wars.

All this had a great impact on the construction costs. The estimate of a river valley project is made at a point of time and the project is executed over a period of time. Other things remaining same the comparison of estimates at two points of time is valid only on the assumption of constant price. This obvious fact is often forgotten; at least, mixed up at par with other causes of escalation.

88. Water resources projects take a long time to construct. During this long period of execution, sometimes economic and political demands change and sweeping modifications are introduced in the project which materially changes its scope although the title of the project remains the same. This gives a wrong impression about cost particularly when it is compared at two points of time.No comparison is possible between two points unless they are alike in certain basic structures. For study of cost escalation it is imperative that the comparison base for various estimates is clearly brought into focus.

89. The Committee feels that considering the mounting concern and apprehension in public mind about huge increase in cost of water resources projects, there is need to highlight certain vital aspects of project execution which, though well known to planners, are lost sight of by the man-in-the-street who is not always well-informed about the planning mechanisms and the economic policies persued in achieving objectives towards creation of a welfare State. Such policies impinge on execution of projects in every sphere and water resources projects are no exception.

90. Economical and timely completion of irrigation and multipurpose projects depends amongst other things, on availability of key materials like cement, steel, coal, equipment and spare parts as also on transport facilities. Any failure in the timely supply of these items has an immediate adverse effect on the construction schedule. It is well known that supplies of all these items are subject to great shortages. It would, however, be unjust to apportion blame to those responsible for their production without understanding the problems and difficulties faced by them. Take for instance, steel. It has been reported that fall in steel production in the country was mainly due to operational difficulties in some steel plants in the public sector. The labour situation also deteriorated considerably influencing production. Despite programmes aimed at improvement, not much technological improvement could be made inspite of high hopes. The expansion programmes for the existing steel plants as well as programmes for construction of new steel plants are all lagging behind schedule.

Apart from labour problems, one trouble or the other in the technical field crops up. However, efforts are being made to tackle all the technical problems and a Steel Research and Development Board is in the offing. The failure in the supply of equipment by the Heavy Engineering Corporation - another public undertaking held up production of steel. Steps are being taken to improve the management of public sector enterprises which are often responsible for many bottlenecks in the extension of plan projects. All these indeed provide hopes but no certainties for the future. Steel is an important requirement for irrigation projects. Due to shortage, its prices will rise. Due to non-availability in time it will be subjected to pressures of inflation. All these would add to cost escalation.

91. Availability of power generation equipment may be cited as yet another case in the point. With a view to have self-sufficiency in the field of heavy industry and to save foreign exchange on import, production of turbines, generators and other connected equipment was taken up in the public sector and a number of undertakings were established. However, production of equipment for power generation in public undertakings failed due to lack of advance planning delaying execution of power and multipurpose projects and adding to cost. It was reported that not enough co-ordination was maintained by the project authorities and the public sector undertakings. Similarly, for the heavy earthmoving equipment used in the construction of major irrigation & multipurpose projects, policy is to encourage use of materials and machines produced indigenously. However, the usual complaint is that the cost of indigenous goods are high and qualitatively their performance is poor compared to the imported equipment which, in turn, causes increase in unit rates of work and hence the project cost. Again the supplies of such equipment, which is mostly produced in the public sector, are subject to delay. All this is nothing unusual in an industrial economy which is still in its infancy. At the same time these are truths which one must face.

92. While discussing the Public Sector in the Fourth Plan Mid-term Appraisal, the Planning Commission has inter-alia mentioned that the short-fall in overall progress in many important fields is a reflection of the deficiencies in the public sector, in terms of utilisation of existing capacity and implementation of new projects. It has been indicated in the Mid-term Appraisal that investment in Public sector industrial undertakings came to the tune of Rs. 3,700 crores. Its value of production exceeded Rs. 1,000 crores. Inspite of that during 1969-70 it made a net loss of about Rs. 22 crores. It has been reported that there is considerable scope for strengthening the organisation, management and operation of public sector undertakings. Recognising the need for identifying the specific problems of individual units, Government have decided to set up a Steering Group, and remedies for removing the shortcomings are constantly being thought about. Apart from specific problems there are problems common to all public undertakings, which affect their production. There are problems about release of foreign exchange. There are difficulties in getting coal or power or raw materials. Often railroad facilities are not available in the manner desired. Sometimes there are inadequate port facilities. In short, the issues that are faced come in the field of management and coordination at different levels. For long we have been dependent for our livelihood mainly on activities such as agriculture, where the elements of planning and organisation are very much in a flexible shape. As we grow industrially, the better planner we

become. In this transition stage through which the country is passing, some adverse effects and shortcomings are bound to occur in every sector of economy which, in turn, affect the planning & execution of irrigation and multipurpose projects.

93. In view of what has been mentioned above, it has to be clearly appreciated that planning and execution of water resources projects cannot be viewed in isolation from the other sectors of developmental activities in the country. These are subject to the same economic, administrative, social and political constraints as projects in other sectors. Planning of a water resources project is bound to be thrown out of gear if there are failures on the part of those who are responsible for providing items like equipment, construction materials, transport facilities, etc. Such failures cannot be predicted and reckoned at the time of preparation of programmes for execution beyond making conservative estimates for the time required for various concerned activities. In such a situation it would be uncharitable to blame those responsible for planning and execution of irrigation and multipurpose projects for delays and increase in project costs, resulting from such contingencies.

94. There is a general expectation that the estimated costs of works concerning irrigation and multipurpose projects should be as good as those of buildings and roads for industrial projects. The fact is lost sight of that unlike these projects, a river valley project is more complex and its planning involves multi-disciplinary activities to a much larger extent. Starting from such immeasurable forces as public pressure to semi-measurable and measurable factors such as, economic demands, agronomic, geologic, meteorologic, topographic, hydrologic, engineering and management all bear upon the preparation of an irrigation and power project. Such a project involves colossal amount of investigations all of which cannot be completed at the stage of submitting a feasibility report. All the uncertain factors are not necessarily eliminated even when detailed investigations have been done. There are instances where despite reasonable investigations done a at project formulation stage, unfavourable geological conditions were met with on opening the foundations of major structures like dam, barrages, etc. These necessitated major changes in design and costs went up. For these highly complex projects, it is not very much possible to frame a perfect estimate in the first instance. Some increase in cost has always to be reckoned. However, it is always possible by virtue of adequate investigations to restrict such increase within reasonable limits.

## Analysis of Reasons for Increase in Cost

95. As has already been discussed under Chapter 3, there are various factors which contribute to the increase in the costs of projects. In the detailed case studies done by the Committee for selected projects with a view

to ascertaining the impact of each factor in quantitative terms, penetrating analyses were made of the cost increases to allocate them to the various factors instrumental in the cost escalation. For this purpose apart from the replies received in response to the questionnaire which did not reveal the complete picture, recourse had to be taken to the data presented in the project reports. These too were not adequate and had to be supplemented by discussions with the field staff engaged in the project in many cases. Project figures were repeatedly revised. The revised estimates had been drawn up either with insufficient details or in a way different from the original estimates. This presented problems in linking up revised figures with original estimates. Assistance of project officers in the field had to be taken in great measure to identify the reasons for increase in cost. The studies were supplemented by field visits to three major projects.

96. The comparison of original and revised estimates was done at 'constant price' to bring out the cost increase due to inflation as far as possible. The revised estimated costs were 'scaled down' to price levels prevailing at the time of preparation of the original estimates in order to get a true picture about cost increases on various counts. Attention was focussed to identify the principal causes of cost rise and delay. As mentioned above, the data presented in the project reports and more so in the revised estimates defied appropriate statistical analysis. Causes could not always be identified in quantitative terms. Statistical analysis in all situations, particularly in those where data are not properly defined and adequately measured, do not always lead to valid results. They must be supplemented with the intelligent appeal to experience. Subjective analysis and opinions of experts cannot absolutely be ruled out as unscientific. A blending of the two methodologies seemed most appropriate to the subject under investigation. The idea was to adopt a realistic and manageable course of action.

97. The cost increases have been identified as under:

Rise in prices;

Inadequate investigation;

Inadequate provision;

Change in scope;

Changes in design and additional requirements; and

Other causes like increase in land rates, rehabilitation measures, paucity of funds and poor performance of equipment.

Apart from the causes mentioned above which are susceptible to quantification to a fairly accurate degree, the Committee could identify other factors which affected almost every project to a varying degree and in some cases were responsible for serious setbacks. These fall within the realm of execution and management. Execution of projects is very often subjected to administrative bottlenecks, inadequate planning for men and materials, poor management at technical levels, failure of contractual agencies, labour troubles, etc. The end result here is also the same, that is, the construction is delayed and costs mount. Despite pointed questions asked in the questionnaire addressed to selected projects to indicate separately the actual delays that have occurred in the project execution due to non-availability of equipment and spare parts, difficulty in procuring the construction materials like cement and steel, delays in decision making, inadequate availability of funds, etc., they were unable to pin-point delays attributable to each cause quantitatively. The delay and cost increase due to these factors defied quantification as they got mixed up with the tangible ones. Investigations, estimating, preparation of comprehensive schemes, designs, budgeting, etc. all contain in them the element of management and if they have caused the increase, the lapses in management have a share in them. But its weight could not be segregated and to this extent the analysis made suffered. Even then, in view of the great impact of the management factor on the rise in costs of projects, the Committee has deliberated at length on this aspect which it could assess through detailed discussions with persons responsible for the execution of the various projects.

98. The analysis made provided a fairly correct insight into the structure of the cost escalation bringing out the relative magnitude of the various contributing factors. And it helped to think about the remedies considering the importance of each factor in the total escalation structure. The results of the enquiries made by the Committee and its findings have been discussed quite exhaustively in the chapters following.

# 8. COST ESCALATION DUE TO RISE IN PRICES

## 8. COST ESCALATION DUE TO RISE IN PRICES

99. A glance at the table given in Appendix 2: Cost Escalation of Major Irrigation and Multipurpose Projects, will show that large irrigation projects about whose cost escalation the Committee was particularly concerned were mostly started after 1961. A review of the general economic situation of the country during the decade that followed may be interesting in this connection. Appendix 5: Statistical Indicators, gives a list of price series which may help to review in broad terms the stress and strain through which the country passed during the crucial period under discussion.

The Wholesale Price Index: All Commodities with base 1961-62 =100 reached 191 in March 1972 registering an increase of 91 percent. During the same period the Index for 'Fuel, Power, Light and Lubricants' reached 176 showing an increase of 76 per cent.

Coming down from the indicators of overall economic situation to price indices of important materials used in the construction sector viz. cement and steel, it is noticed that the wholesale price index of cement with the same base of 1961-62 = 100 and the same period, viz. upto March 1972 went up to 163 registering an increase of 63 per cent. On the same count, Iron & Steel Manufacture went up to 183 registering an increase of 83 per cent.

No reliable series, which can give an indication of the increase in labour cost in irrigation projects is available officially. The series officially published relates to 'Average annual earnings of factory employees', the statistics relating which are collected under the Payment of Wages Act. Considering a base 1961 = 100, the index reached 172 in 1970 showing an increase of 72 per cent in nine years.

There is no index to indicate the price rise of machinery and equipment used in the construction of irrigation and multipurpose projects. During the decade 1961-62 to 1971-72, the construction machinery of this sector comprised mostly imported machinery. The index available with the Ministry of Foreign Trade is the "Index of unit value of imports: Machinery other than electrical". Considering the base 1961 = 100, this index reached 237 recording an increase of 137% in eight years.

100. In Chapter 7: Dynamics of Project Estimates it has been mentioned that a realistic comparison of cost involves comparing like with like. The estimates for irrigation and multipurpose projects are made at a point of time whereas these projects are executed over a period of time. Everything else remaining same, comparison is valid only on the assumption of constant price. A review of general economic situation has shown that prices were not constant.

101. It has been explained in Chapter 7 that the planning and execution of water resources projects cannot be viewed in isolation from the other sectors of developmental activities in the country. Planning of these projects will be thrown out of gear if there are failures on the part of those who are responsible for providing items like equipment construction materials and transport facilities. It has also been brought out that other sectors are striving hard to improve which provides hope but not certainties for the future. In view of the revolutionary social and economic changes through which the country is passing, it may be difficult to hold the price line. It has been brought out that our economic well being mainly depends on monsoon which is an unpredictable factor. Inflation also depends on that, everything else remaining the same. And lastly, as long as population is growing at the present rate and commodity production is not growing at the rate desired, prices are bound to grow. Inspite of all this no provisions are made in an estimate to have a cushion for such changing phenomenon in the economic scene. Perhaps as an administrative expedient it is justifiable, Arguments are advanced that provisions for such exigencies will firstly encourage contractors to overbid and secondly destroy initiative of project authorities to achieve economy in construction.

102. The Committee went over this question very carefully. No radical change in the existing administrative procedure to prepare plan estimates at current prices is possible. However, as an instrument of planning it would be unrealistic if no arrangements are made to take notice of the crucial factor of inflation. For this purpose a suitable cushion should be devised which may fit in with the governmental financial mechanism. Approval of a scheme takes some time. Commencement of real construction work after approval also takes time. Then comes the construction period. It is recommended that to cover the increase owing to economic changes over the long period, an appropriate indicator of price rise may be constructed and the increase so obtained added to the estimate as a 'supplementary provision' for adjusting cost estimates of plan projects. Such provisions will create a sense of awareness in those who are responsible for making financial arrangements. It will also fix responsibilities for different components of price rise in a realistic manner.

103. Before coming to this adjustment factor, it may be seen how the change in the economic situation pushed up the estimates of the six major irrigation and

multipurpose projects that the Committee examined in detail. The table below indicates the increase owing to escalation of prices as percentage over the original estimated cost.

| | Original Estimate (Rs. in crores) | Revised Estimate (Rs. in crores) | Increase (Rs. in crores) | Increase due to escalation of prices (Rs. in crores) | Increase due to price escalation as % of original estimate |
|---|---|---|---|---|---|
| Beas-Sutlej Link Project, H.P. | @<br>94<br>(1961) | 180<br>(1970) | 86 | 42 | 45 |
| Ukai Dam Project, Gujarat. | @<br>55<br>(1961) | £<br>109<br>(1970) | 54 | 24 | 44 |
| Ramganga River Project, U.P. | 40<br>(1958) | 131<br>(1971) | 91 | 48 | 120 |
| Jayakwadi Project, Maharashtra. | *<br>36<br>(1965) | 74<br>(1971) | 38 | 14 | 39 |
| Kangsabati Project, West Bengal. | 25<br>(1956) | 46<br>(1970) | 21 | 9 | 35 |
| Kallada Project, Kerala. | 13<br>(1966) | 45<br>(1970) | 32 | 14 | 107 |

@ Exclusive of Transmission System.
£ Indicated in Annual Plan discussion.
* Sanctioned by the State Government.

104. With a view to finding out the adjustment factor, it will be helpful to study the average annual increase owing to escalation of prices recorded by these projects. For this purpose the increase will be compared with the original estimates enhanced to take into account all the subsequent additional provisions reduced to the price level prevailing at the time of preparation of the original estimate. Also, the cost under B-Land will be left out as the increase in cost of land is only at a point of time that is when the prices are settled by Court awards and is found to be phenomenal having no bearing on the general escalation of prices (see Chapter 13). With these adjustments, the average annual increase in cost of the six projects would be as follows:-

| | Increase due to price escalation | | |
|---|---|---|---|
| | % of adjusted original cost | Period | Average annual increase % |
| Beas-Sutlej Link | 32 | 1961-70 | 3.5 |
| Ukai Dam | 29 | 1961-70 | 3.2 |
| Ramganga | 62 | 1958-71 | 4.8 |
| Jayakwadi | 33 | 1965-71 | 5.5 |
| Kangsabati | 28 | 1956-70 | 2 |
| Kallada | 45 | 1966-70 | 11.2 |

The average annual increase in Kallada Project is high because practically no work has been done in that project. The expenditure when the project was revised in 1970, was only about Rs. one crore out of the revised estimated cost of Rs.45 crores. Almost the entire original estimated cost has borne the four years' escalation. As such, this is not a proper example to be considered here.

Kangsabati project is a very old one which commenced in 1956. Quite an appreciable amount of work was done at very low rates with machinery obtained from Mayurakashi project and before the appearance of marked inflation in the economy of the country. This is also an example to be left out.

Beas-Sutlej Link Project has shown an average annual increase of 3.5%. During the Committee's session at Sundernagar from 29th September, 1972 to 1st October, 1972, the Chief Engineer indicated that as per revised assessment now made, the estimated cost of the project for civil works is likely to increase by Rs.27 crores in 1972 of which about Rs.21 crores would be owing to escalation of prices. Taking this into account the average increase works out to 4.1% per year. This does not take into account any corresponding escalation on the electrical side which has not been intimated. The average increase would, as such, be still higher.

In Ukai Dam Project, the average annual increase has come to 3.2%. The revised estimate prepared on 1970 rates has not been submitted by the State Government to the Planning Commission. Although the dam is nearing completion, practically no work has been done on canals and distributaries. From the copy of the revised estimate which the Chief Engineer made available to the Committee for its work, it is found that the rates adopted for excavation of canals are very much on the low side. The unit costs of cross-drainage works have been kept slightly more than in 1961 estimate. The revised estimate has not been updated properly in this portion. The annual increase worked out may as such, go up to nearly 4%.

From the above it would be seen that the average annual increase in the costs of four projects owing to escalation in prices ranged practically from 4% to 5.5%.

105. It is necessary at this stage to see how the escalations discussed above compared with the average yearly escalations of costs obtained through Construction Cost Index of river valley project works.

There is no organisation or publication in the country which maintains any index of construction cost applicable to such constructions. In the absence of any such index being available, the Member-Secretary of the Committee made a few studies of the cost trends of some important items of works and in the two sessions of the Committee, one held at Ukai Dam Project site in Gujarat on 12th & 13th September, 1972 and the other at Beas-Sutlej Link Project headquarters at Sundernagar in Himachal Pradesh from 29th September to 1st October 1972, he presented the construction cost index and graph prepared with 1961-62 base of 100 for four items of works viz. earthwork by machinery, earthwork by manual labour, reinforced cement concrete and stone masonry. These form bulk of the works in the various projects and the trends of costs of these items would, it has been assumed, be representative of the cost escalations the projects have gone through during the last 10 years.

There are severe limitations to the preparation of a construction cost index of any item of work which can represent all of its kind. The earth dam may be done by excavating the earth with a shovel and transporting the same by dumpers; this may also be done with elevating graders and dumpers or with motorised scrapers. The concrete dam may be constructed through a fully mechanised method or a partial one. The composition of concrete or masonry is going to be different depending on technical requirements. And above all, the leads of construction materials involved (i.e. distances from which they are to be brought) which rule the rates will be different in different projects.

Again, not all the price indices officially available are applicable to the type of construction in the river valley projects. The index for 'average annual earning of factory employees' available from the Labour Bureau, Ministry of Labour, Employment & Rehabilitation does not serve the purpose of irrigation projects. The labour employed in the construction projects is of casual nature and the rise in labour wages in this sector was more sharp than of the permanent type of employees in the factories. The price index of 'fuel, power, light and lubricants' published by the Ministry of Industrial Development, Internal Trade and Company Affairs is heavily weighted with coal and will not represent the construction necessity. The index of unit value of imports for 'machinery other than electrical' does not bring any worthwhile statistics because one unit is not comparable with another unit unless both are of similar capacity. These basic indices had to be constructed from whatever information was available from other sources.

The methodology adopted in working out the construction cost indices of the four items of work has been given in brief in Appendix 6. The trend of cost escalation of these items may be seen from the graphs attached. These composite indices would depict the escalation of cost of works better than the price indices of individual items like cement, steel, machinery, etc.

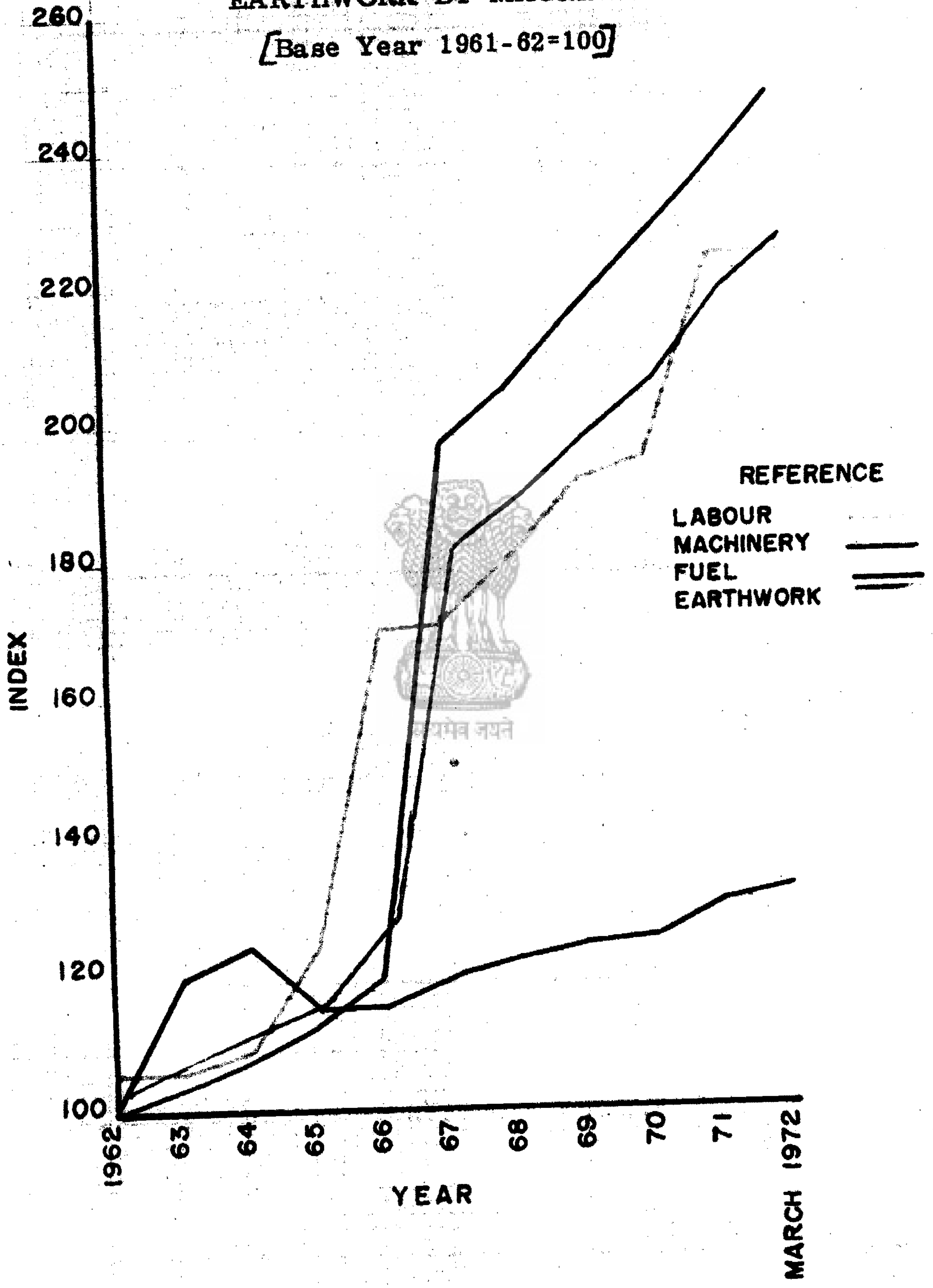
106. From the following table can be seen at a glance the trend of construction costs of these works items with 1961-62 base of 100.

CONSTRUCTION COST INDEX
(Base 1961-62 = 100)

| Year<br>1 | Earthwork by machinery<br>2 | Earthwork by manual labour<br>3 | Reinforced concrete<br>4 | Stone masonry<br>5 |
|---|---|---|---|---|
| 1961-62 | 100 | 100 | 100 | 100 |
| 1962 | 101 | 100 | 102 | 102 |

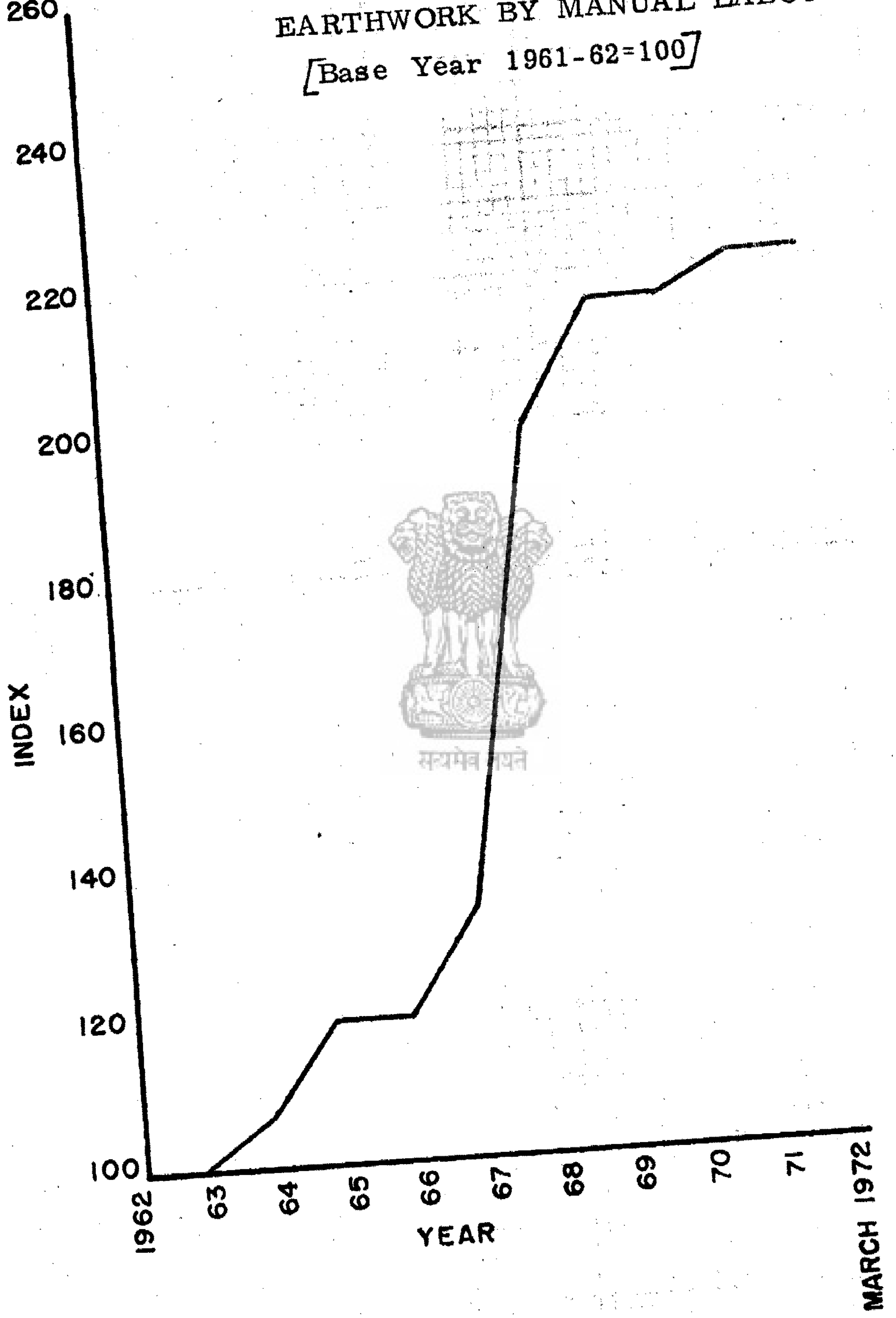
# CONSTRUCTION COST INDEX FOR EARTHWORK BY MACHINERY

[Base Year 1961-62=100]



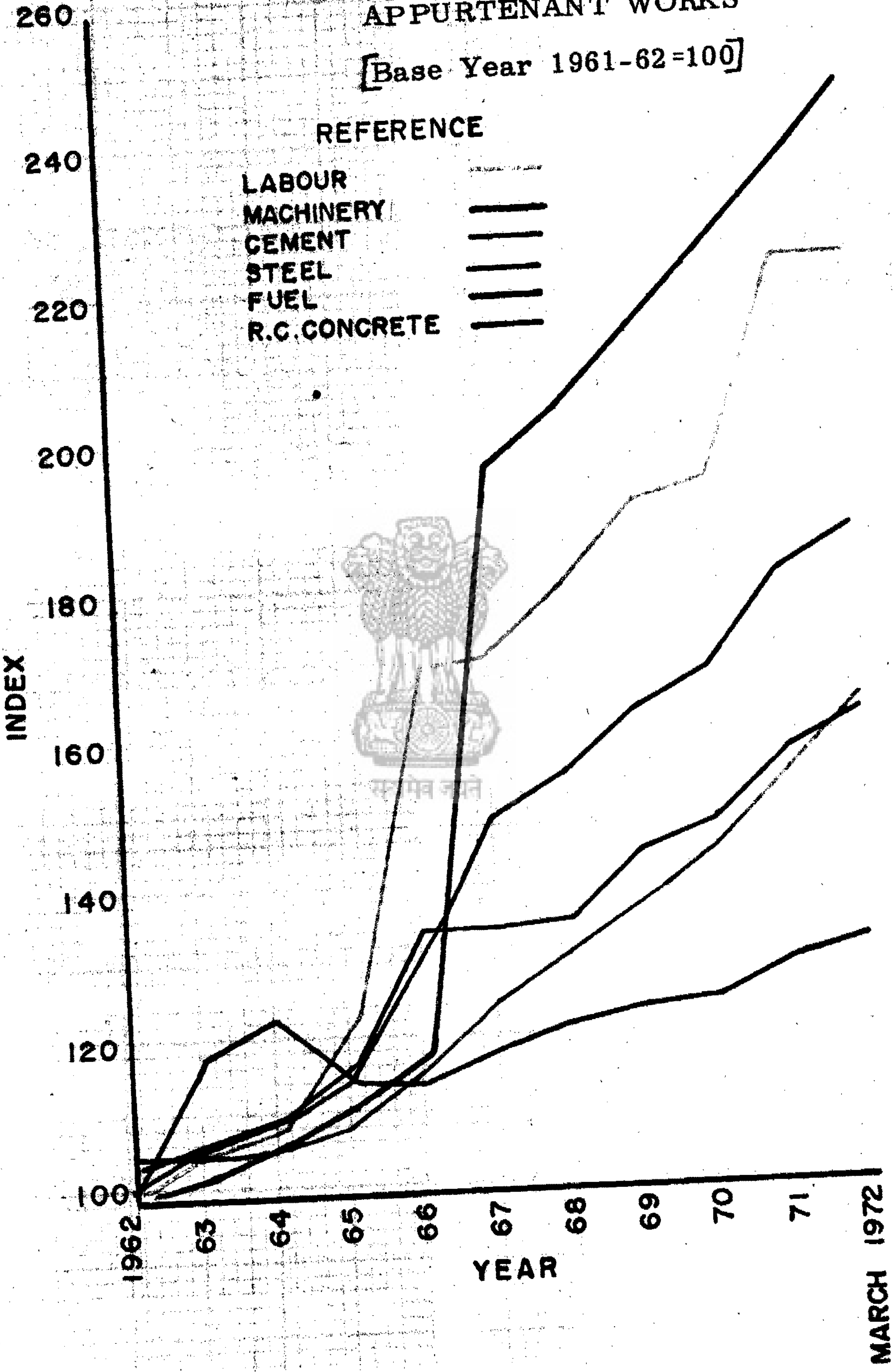
## CONSTRUCTION COST INDEX FOR EARTHWORK BY MANUAL LABOUR

[Base Year 1961-62=100]



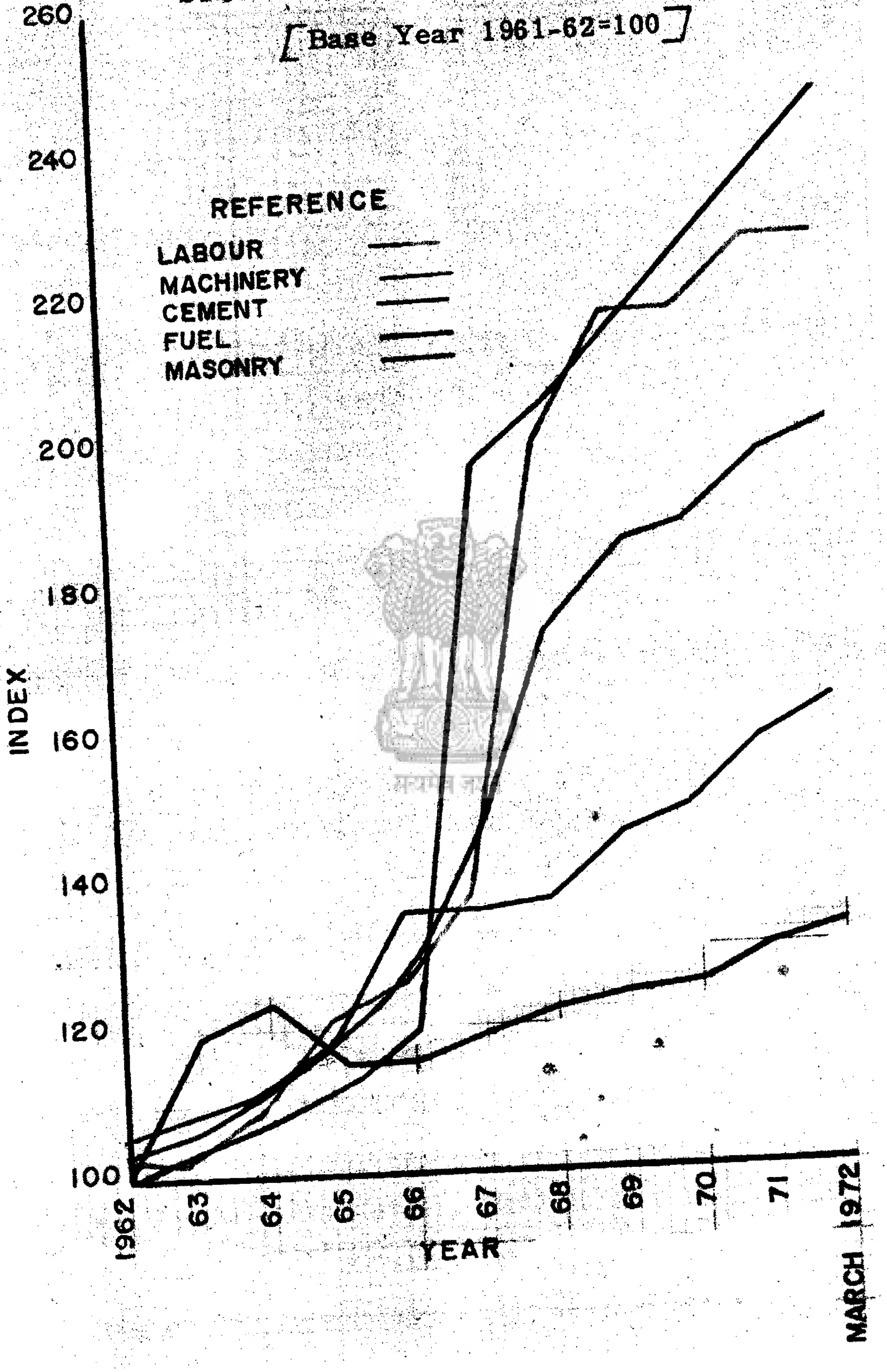
## CONSTRUCTION COST INDEX FOR R.C. CONCRETE 1:2:4 IN DAM AND APPURTENANT WORKS

[Base Year 1961-62=100]



## CONSTRUCTION COST INDEX FOR STONE MASONRY IN C.M.1:5 IN DAMS

[Base Year 1961-62=100]



| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 1963 | 106 | 100 | 106 | 105 |
| 1964 | 110 | 107 | 109 | 110 |
| 1965 | 114 | 120 | 114 | 117 |
| 1966 | 126 | 120 | 130 | 128 |
| 1967 | 180 | 135 | 149 | 145 |
| 1968 | 187 | 200 | 154 | 173 |
| 1969 | 196 | 217 | 163 | 185 |
| 1970 | 204 | 217 | 168 | 188 |
| 1971 | 217 | 223 | 182 | 197 |
| 1972 (till March) | 225 | 223 | 188 | 201 |

We find from these construction cost indices that during the period of 10 years from 1962 to 1972 the average yearly escalations were as follows:-

| | | Total increase (%) | Average yearly escalation (%) |
|---|---|---|---|
| 1. | Earthwork by machinery | 125 | 12.5 |
| 2. | Earthwork by manual labour | 123 | 12.3 |
| 3. | Stone masonry | 101 | 10.1 |
| 4. | Reinforced concrete | 88 | 8.8 |

The cost escalations of all these items indicate that due to inflation, costs of major works have gone up during the last decade at an average annual rate ranging from about 9% to 12.5%.

107. It will be worthwhile to examine the type of cushion these average annual cost escalations of works would provide if applied to a project estimate for the entire period from the formulation to the completion of the project under average conditions. For this purpose, a project which takes two years to be approved by the Planning Commission and another two years to start the actual construction and some six years to execute and construct the project, may be considered.

At 9% per year escalation, the average annual increase on the project estimate over the entire period i.e., the available cost cushion would be 6.3% (i.e. $\frac{9\% \times 4 \text{ yrs.} + \frac{1}{2} \text{ of } 9\% \times 6 \text{ yrs.}^{*}}{10 \text{ yrs.}}$). At 12.5% per year, the corresponding increase would be 8.8 % per annum (i.e. $\frac{12.5\% \times 4 \text{ yrs.} + \frac{1}{2} \text{ of } 12.5\% \times 6 \text{ yrs.}}{10 \text{ yrs.}}$). In case there is no delay in sanctioning the project the increments with the aforesaid factors would be 5.6% per annum (i.e. $\frac{9\% \times 2 \text{ yrs.} + \frac{1}{2} \text{ of } 9\% \times 6 \text{ yrs.}}{8 \text{ yrs.}}$) and 7.8% per annum (i.e. $\frac{12.5\% \times 2 \text{ yrs.} + \frac{1}{2} \text{ of } 12.5\% \times 6 \text{ yrs.}}{8 \text{ yrs.}}$), respectively. If further, the construction could be taken up without loss of time, the average increase would, on a rough basis, come to 4.5% and 6.3% per annum respectively.

It may now be assumed that the aforesaid project takes 8 years to be constructed instead of 6 years, the time for sanction and preparation remaining the same. The corresponding increases when worked out and compared would look as under:

| | Period | Cost cushion, average annual in % | |
|---|---|---|---|
| | | With 9% escalation | With 12.5% escalation |
| | 1 | 2 | 3 |
| 1. | 10 yrs. with 6 yrs. of construction | 6.3 | 8.8 |
| 2. | 8 yrs. with 6 yrs. of construction | 5.6 | 7.8 |

(contd..)

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* Increase in cost during the period of construction owing to escalation of prices depends on when the expenditure is incurred. For the purpose in view, it is assumed that the rise and fall of the tempo of work and hence the expenditure is so distributed that the escalation in one half of the amount or one half of the factor for full amount.

| | 1 | 2 | 3 |
|---|---|---|---|
| 3. | 6 yrs. construction with no loss of time for approval and preparation | 4.5 | 6.3 |
| . | 12 yrs. with 8 yrs. of construction | 6.0 | 8.4 |
| 5. | 10 yrs. with 8 yrs. of construction | 5.4 | 7.5 |
| 6. | 8 yrs. construction with no loss of time for approval and preparation | 4.5 | 6.3 |

It is seen from the foregoing table that under different periods of formulation and construction considered, the overall estimated cost of a project gets a cost cushion ranging from 4.5% to 6.3% per annum average with an escalation of 9% per year and from 6.3% to 8.8% with an escalation of 12.5% per year.

108. If the results of all these examinations are summarised, then the position will be as given below:

| | | |
|---|---|---|
| 1. | The average annual rate of cost escalation of works owing to inflation | 9% to 12.5% |
| 2. | Average annual cost cushion provided in a project with the application of aforesaid escalations | 4.5% to 8.8% |
| 3. | The average annual increase noticed in the costs of four major projects owing to escalation in prices of material, machinery and labour. | 4% to 5.5% |

The foregoing table shows that the average annual increase owing to price escalations noticed in the major projects is lower than the cushion obtained by applying the average annual rate of cost escalation owing to inflation. This indicates that the increase in cost due to escalation of prices recorded in the projects has taken into account the savings effected by the application of Value Engineering@ technique during construction. The annual escalations of works cost calculated from construction cost index need not, as such be taken for use as escalation factors. A lower factor will have to be chosen so that some scope is left for any possible savings during the course of construction.

It would be necessary to look for an adjustment factor that would cover an annual average increase of 4 to 5% on the overall estimated cost of a project from its formulation to completion.

109. Two adjustment factors may be considered for this purpose, one 8% and the other 7% per year and on the same basis as done with inflation percentages, it would be found that the following cushions would be available with these factors:-

| Period | Cost cushion, average annual in % | |
|---|---|---|
| | With 8% per year adjustment factor | With 7% per year adjustment factor |
| 1. 10 yrs. with 6 yrs. of construction | 5.6 | 4.9 |
| 2. 8 yrs. with 6 yrs. of construction | 5.0 | 4.4 |
| 3. 6 yrs. construction with no loss of time for approval and preparation | 4.0 | 3.5 |
| 4. 12 yrs. with 8 yrs. of construction | 5.3 | 4.7 |
| 5. 10 yrs. with 8 yrs. of construction | 4.8 | 4.2 |
| 6. 8 yrs. construction with no loss of time for approval and preparation | 4.0 | 3.5 |

@ Changes in layout and design during construction which result in savings in the project cost.

It is seen that an escalation factor of 8% per year covers an average annual increase ranging from 4% to 5.6% while a factor of 7% per year gives a cushion of 3.5% to 4.9%.

110. The committee after detailed discussions and careful consideration of the question, and keeping in view the limitations of the involved analysis preferred to accept an 'Adjustment factor' of 7% per year. This amounted to adoption of a factor which is lower than the annual cost escalations of construction costs ranging between 9% to 12.5% and which would be expected to cover an annual average increase of 3.5% to 5% rise in the overall cost of a project owing to inflation. In other words the Adjustment Factor is so chosen that it takes care of the strain brought on the projects owing to economic changes over the long period, only after it has encouraged the Value Engineering technique to play its part.

111. The Committee, therefore, recommends that an Adjustment Factor of 7% per year should be adopted in working out the 'Supplementary provision' for adjusting the cost estimates of plan projects. In applying this factor the estimated cost of the project should be relieved of the cost of land and only 50% of this factor should be considered for the period of actual construction.

This adjustment factor is not meant to be applied to a project estimate where the commencement of actual construction is delayed by more than four years from the time of preparation of the estimate, due to long time taken in the approval of the project or its preliminary works or any other reason. In such a case the estimate should first be updated and then the escalation factor applied.

112. The Committee further recommends that the adjustment factor should be reviewed from time to time after taking into consideration all aspects of the economic situation in the country. For this purpose the Central Water & Power Commission should have a permanent study cell for collection of data and preparation of Construction Cost Index for the works of river valley projects.

113. The reasonableness of taking into account the increase owing to escalation of prices in the cost estimates has been borne out by the article entitled "Total cost of a project" appearing in the publication "Consulting Engineering" of the American Society of Civil Engineers No. 45 of 1972. The relevant portion of this article is reproduced hereunder:

> "If construction is not started promptly and material time elapses between estimate and construction, another factor must be included. Construction costs have been rising in the United States for many years and, if the present (1971) cycle of inflation continues, such rises will occur in the future.
>
> There are many studies of trends of construction costs available, one of the best being the Index of Construction Cost of the

Engineering News-Record. With a 1913 base of 100, recent indexes are as follows:

| Year | Annual average | Annual increase in % |
|---|---|---|
| 1961 | 847 | 2.79 |
| 1962 | 872 | 2.95 |
| 1963 | 901 | 3.33 |
| 1964 | 936 | 3.88 |
| 1965 | 971 | 3.74 |
| 1966 | 1019 | 4.94 |
| 1967 | 1070 | 5.04 |
| 1968 | 1154 | 7.81 |
| 1969 | 1270 | 10.09 |
| 1970 | 1380 | 8.66 |
| 1971(Preliminary) | 1571 | 13.84 |

The Engineering News-Record cautions that its'..... construction cost indexes reflect wage rate and material price trends. They do not adjust for labour, for job efficiency, material availability, competitive conditions, management, mechanisation, or other intangibles affecting construction costs.'

From the foregoing it can be seen that significant yearly increments may have to be added to estimates of costs when construction is delayed. It can be seen also that a definite date must be assigned to all cost estimates in the Engineer's reports".

# 9. COST ESCALATION DUE TO INADEQUATE INVESTIGATION

## 9. COST ESCALATION DUE TO INADEQUATE INVESTIGATIONS

114. If there is one factor that has caused significant deviation from the original estimated costs of irrigation projects it is the lack of adequate investigations and surveys before the preparation of the project estimates submitted for approval of Planning Commission. It has been pointed out by on engineer-in-chief of a State that "There is always a rush for quickly preparing a feasibility report for transmitting it to the decision making authority. Neither sufficient time nor adequate personnel are made available for doing a good and accurate job on the preparation of a feasibility report". It is noticed that while investigations are still done for the headworks like dams and barrages much less attention is paid in this respect to the distribution system. It is, therefore, no surprise that the estimates turn out to be grossly understated.

115. Jayakwadi Project in Maharashtra is an example. Out of a total increase of nearly Rs.38 crores in the revised estimate, about Rs.9 crores representing nearly 24% of the increase, could be broadly identified as due to inadequate investigations.

Lack of detailed survey of the reservoir area contributed to about Rs.383 lakhs increase by way of increased number of villages and structures (Rs.370 lakhs) and more land (Rs.13 lakhs) to be acquired. Incomplete investigation of borrow areas contributed to about Rs.78 lakhs in earth dam.

When the original estimate was prepared in 1965, preliminary survey of only about 14 miles out of a total 115 miles of the main canal was done and classification of soils was based on the investigation of the canal on the other bank (R.B. Canal) of which 34 miles had been surveyed and investigated. The result is that the change in soils classification increased the cost by about Rs.96 lakhs, changes in lead of material by Rs.24 lakhs, deeper foundations of cross-drainage works by Rs.35 lakhs, and increased length of canal (8 miles) and change in alignment by Rs. 17 lakhs.

No surveys were done for the distributaries and minors and provision was made at Rs.44.00 per acre of G.C.A. on the basis of Purna Project estimate without considering the actual site conditions here. The rate has been enhanced to Rs. 140.00 per acre in the revised estimate. The inadequate survey and investigation of the distributary system contributed towards the increase in cost to the tune of Rs. 200 lakhs.

116. In Ukai Dam Project of Gujarat, nearly Rs.4.5 crores representing over 8% of the total increase of Rs. 54 crores could be attributed to inadequate investigation.

The earth dam shared an increase of about Rs. 300 lakhs on this account. The initial investigation does not seem to have been exhaustive enough to detect a shear zone in the foundation which necessitated change in alignment and layout of works, increasing the quantities of work under stripping, earthwork as well as drilling & grouting. A major part of this increase was further due to increased leads for hearting and casing materials from 2 miles to over 4 miles and for sand from 2 miles to 10 miles which suggested that borrow area investigations were totally inadequate.

Due to inadequate survey of land and property coming under submergence, there was an increase of about Rs. 52 lakhs towards payment of compensation for acquisition of land and structures.

In the canal system, lack of proper soil survey at the initial stage necessitated excavation of harder material than assumed which resulted in an increase of about Rs. 20 lakhs. For the same reason there was an increase of Rs. 18 lakhs in the power house. To bring up the desired extent of areas under irrigation, the main canal had to be extended by 12 kilometres and two branch canals, one by 18 km. and the other by 8 km. which contributed over Rs. 40 lakhs to the increase. Apparently, the initial surveys conducted while framing the original estimate were not adequate enough.

117. Kangsabati Project of West Bengal is a typical case where work started immediately with the selection of a site for the construction of the dam in 1956. Investigations went hand in hand with construction. No wonder that out of about Rs.21 crores increase, inadequate investigations accounted for nearly Rs. 6.7 crores i.e. about 33%.

To mention the major increases, lack of proper investigation of borrow areas for earth dam contributed to over Rs. 90 lakhs to this account. Foundation of spillway & tail channel and increased requirement added to about Rs. 175 lakhs. There was a saving of Rs. 70 lakhs as the land to be acquired for the reservoir was found to be much less than the initial estimate.

The canal system was not properly surveyed with the result that filling reaches were found to be more than estimated increasing the cost by Rs. 46 lakhs. Additional leads and lifts accounted for about Rs. 30 lakhs. Increase in the number of canal structure was responsible for a rise of about Rs. 136 lakhs. No soil survey was done for the final alignment for which reason change in classification of soils from what was considered earlier alone contributed to an increase of about Rs. 250 lakhs.

118. Coming to Ramganga Project of Uttar Pradesh, it will be found that subsequent to the preparation of the 1958 estimate which was approved by the Planning

Commission in 1959, a fault zone was discovered below the thick alluvium of the Gangetic Plains which made the dam site liable to very severe earthquake. This necessitated change in the design of dam and other features with an upward revision of the estimate by Rs.320 lakhs in the 1961 proposals.

Again, it was realised that if a rainfall similar to one recorded in 1880, as pointed out by the High Level Committee on Floods 1957, occurred in the catchment area, the Ramganga river might bring a flood of the order of 3,75,000 cusecs. This would be very much higher than the assumed 2,50,000 cusecs in the 1958 report. This required increasing the capacity of the spillway in the 1961 proposals and provision was made of one chute spillway and one tunnel spillway instead of two tunnel spillways considered earlier. This resulted in a rise of nearly Rs.200 lakhs in the spillway and about Rs.75 lakhs in the weir and training works.

Inadequate investigation of the feeder channel increased the cost by about Rs.155 lakhs of which Rs. 9 lakhs was due to subsequent modification of leads for earthwork; Rs.60 lakhs due to type of land and area for the channel and headworks; Rs.86 lakhs for not making any provision of two major syphons for the channel to cross the rivers Salara and Chhola and other works in the original estimate.

For the same reason an additional amount of about Rs.122 lakhs was found necessary in the upper and lower Ganga canals to provide masonry works, escapes and drains.

The modifications found necessary in this project on account of inadequate investigations at the initial stage are found to be of the order of Rs. 10 crores which is about 11% of the total increase of over Rs.91 crores.

119. In Kallada Project of Kerala, no work on canal and very little on Dam had been done when the estimate was revised in 1970. Even then, we find that out of a total increase of Rs. 32 crores, nearly Rs.6.5 crores can be classified as coming from inadequate investigations. Of this, additional requirement of land to dump excess soil from the canal and distributaries cost about Rs. 1 crore, change in classification of soil about Rs. 1.4 crores, and increase in length and number of acqueducts Rs. 3.4 crores. More may be in reserve to appear when the actual work is taken up.

120. Beas-Sutlej Link Project is another example which underlines the importance of proper investigations for timely and economical execution of a project. This project which aims at diversion of Beas waters into the river Sutlej is essentially a tunnelling project in which construction of two tunnels totalling to about 17 miles in length is envisaged. The tunnels are aligned through a region having complex geological features. One of the tunnels - Sundernagar-Sutlej tunnel is aligned through a narrow band of rock which has one major fault known as Gobri

Fault along one side and a thrust called Kroll Thrust on the otherside. It would appear that not much cogizance of the difficulties likely to crop up in such a situation was taken at the time of framing the original estimate as rates of progress and excavation cost were assumed exactly same as for the other tunnel (Pandoh-Baggi Tunnel), which runs through comparatively better strata. Actual excavation of S.S. Tunnel has brought many surprises. The first 3000 ft. of tunnel at the Pong heading is running through the overburden reach of a Khad and is 100ft. below the water table and highly saturated. Progress assumed in the framing of the original estimate was 275 ft. per month in each heading. The boring of the tunnel in this reach is going on at snail's pace, the excavation being done by heading & benching method, that too in parts, as against a full face working originally visualised. In one reach the tunneling was expected through rock. But instead, sand and boulders under water pressure have been encountered making the tunnelling job very difficult and hazardous. Again, in this very tunnel, as the strata on the 'fault' side was saturated with water under very high pressure, there was a major collapse in the tunnel in June, 1969 when a lot of material flowed in covering a length of about 900 ft. of the tunnel. As a result this heading had to be abondoned and the alignment of the tunnel changed.

In the Pandoh Baggi tunnel, boring is generally through phylites and blocky but jointed granites. In addition, there are bands of schists, which form the treacherous crushed zones through which tunnelling cannot be done with full heading and the work is considerably delayed. There is a continuous reach of about 2000 ft. on Pandoh side in schist and the progress of tunnelling is between 60 ft. to 90 ft. per month as against a normal expectation of 270 ft. per month. In this reach the steel ribs used as supports are twisted and displaced by as much as two feet by the pressure of the rock. Such a continuous reach with this kind of load development was not predicted earlier. The earlier assumption was that such weak strata would form about 12% of the excavation, which, according to the latest assessment, has gone up to 25%.

Because of the problems mentioned above, the entire schedule for tunnel construction, on which depended the completion of the project, got out of gear. Had the investigations been done more exhaustively at the initial stage, some of the situations could have been foreseen earlier, the construction methods suitably modified, a more realistic assessment of time required for completion made, and thus delays and additional costs in tackling the problematic reaches materially cut down.

121. The Committee has come across another case where the feasibility report of a major project was prepared without adequate investigation. In Pochampad Project in Andhra Pradesh, which is designed to utilise the waters of the river Godavari for irrigation purposes, the original stipulation was to serve an ayacut of 5.7 lakh acres for which a main canal of 68 miles length along with a branch canal was proposed. In reply to the questionnaire sent by the Committee, it has been stated by the project authorities that on detailed survey it has been found that only an ayacut of 4.50 lakh acres is available upto a point earlier envisaged. In order to utilise fully the available water, the length of main canal has to be extended by

another 55 miles to command the balance 1.2 lakh acres. In this process, the canal has to cross a major river, the river Manair, by constructing a dam across it. The additional cost on account of the additional 55 miles length of the main canal and the dam required on the Manair for level crossing has been indicated by them as Rs.14.81 crores, which represents about 38% increase over the original estimated cost of the project viz. Rs.40.10 crores. The estimated increase in cost is not based on any designs as surveys are still in progress, and it has been stated by the project authorities that the costs are likely to increase still more on this account.

It has been further stated in reply to the questionnaire that in the revised project estimate (cost: Rs.90.25 crores), the provision for canals is based on detailed estimates prepared upto mile 23 and on prorata cusec-mile basis beyond mile 23. The detailed estimate prepared subsequently for the reaches beyond mile 23 have indicated that the provisions based on cusec-mile basis in the revised estimate are inadequate. It is obvious that even at the stage of preparation of the revised estimate, surveys for the main canal are not complete and provisions are made on the basis of parametric estimates.

122. Yet another project, Ghataprabha Project Stage II in Mysore has the same story to tell. The Hidkal Dam, forming the headworks of this scheme, is a storage dam being constructed across the river Ghataprabha for impounding water for irrigation. The original estimate for this project was first approved for Rs.8.50 crores in 1960. Subsequently, a number of changes were made in the sanctioned proposals in respect of the dam alignment, section, and layout of various components of the dam works and a revised estimate incorporating all the changes was approved for Rs.20.00 crores in 1962. Thereafter, work on the excavation of the dam foundation was taken up in 1962-63. In course of the excavation, the following major geological features, unfavourable for the masonry dam structure proposed, were revealed:

(i) a major fault zone traversing the dam axis obliquely,

(ii) bands of shales of widely varying strength characteristics,

(iii) a minor longitudinal fault running along the dam alignment in the non-overflow portion on the right flank,

(iv) minor shear zones across dam alignment on the left flank; and

(v) a monodual flexure between certain chainages of the dam.

More investigations followed and drastic changes were made in the design and layout of the dam. A rockfill dam section was adopted in the portion which was earlier meant for spillway and where the fault zone was discovered. The right bank earthen dam was changed to a masonry section 4100 ft. long. Apart from these there were other changes in designs and specifications of works. As a result of these changes, the cost of the project was revised in 1966 to Rs.35.00 crores (including Rs. 3.0 crores increase in land cost) and work on the project could be resumed in 1966 only.

123. All these distortions and difficulties suggest only one thing that the investigations have to be done more thoroughly for preparing a project report and its estimate for approval by the Planning Commission. It is, no doubt, appreciated that the investigation of a major river valley project cannot be completed in all respect at that early stage. It would not unreasonable to expect that it could be done up to such a level as would not necessitate material change in the designs and substantial variation in quantities of works at the detailed investigation stage, thereby involving wholesale revision of the estimates prepared.

124. In this connection, the Committee found that the Central Water & Power Commission (Water Wing) has recently laid down the minimum investigations to be carried out before preparation of project report and estimate for approval of the Planning Commission which it circulated to all the State Governments during February/March, 1972. Later it has further modified the requirement for canal and canal structures. A copy of the circular letter along with its enclosure (exclusive of the maps) as well as the further modifications are given in Appendix 7 of this report. It is recommended that the guidelines laid down therein should be strictly followed for preparing the reports and estimates of all major irrigation, and multipurpose projects in the country.

125. For investigation of projects in general, each State should have a broad-based organisation involving all disciplines (engineering, geology, hydrology, revenue, agriculture, etc.) so that the work is done by persons experienced and expert in each of the specialised fields.

126. Adequate monetary incentives as well as other compensatory benefits should be provided in order to attract bright and enthusiastic officers to come forward and undertake field investigation assignments under arduous conditions of life.

127. Suitable funds should be allocated for investigating properly the projects proposed. A part of this allocation could be on earmarked basis for investigation of specific important and complex projects.

128. Very big projects costing over Rs.30 crores would require a more strict treatment. In their case the first stage should invariably be the sanction of an Investigation Estimate on the basis of the Preliminary Project Report or Reconnaissance Report. The outlay on such an estimate could be as much as 5% of the anticipated total cost of the scheme and should be sufficient to enable

a well-manned organisation to be set up at the project site for carrying out thorough investigations and preparing detailed estimates in terms of accurate data on quantities, etc. The organisation should be headed by a senior engineer who could be expected to take over the execution of the project also in due course. Feasibility of the proposed project would have been reasonably well established in the Preliminary Report. There is little danger, therefore, of the expenditure incurred on such detailed investigations becoming infructuous. Even if it happens so in a rare case or two, it should be accepted in the same way as expenditure on research which does not always produce positive results. Investigating major projects in fact should be looked upon like research in the harnessing of the natural resources of the country and should be reviewed and accepted as such.

129. The C.W.& P.C. should associate itself closely with the investigation organisations set up by the States and give them necessary guidance and assistance in their work. Such association would be particularly necessary to watch progress in the case of investigations approved in respect of specific important, large and complex projects. This would ensure that the investigations get done with the required thoroughness as well as in the quickest possible time so that there is no large time interval between the approval of a scheme for investigation and its approval for actual execution.

# 10. COST ESCALATION DUE TO INADEQUATE PROVISION

## 10. COST ESCALATION DUE TO INADEQUATE PROVISION

130. From the detailed analysis of the project estimates it has been found that quite a big segment of the total increase in the cost of a project is due to the fact that the original provisions made in the estimate at the time of approval of the scheme were inadequate. A very broad review as in the table below would indicate that initial estimates were not adequate for the construction of the projects envisaged.

| | Total increase on revision (Rs. in crores approx.) | Increase due to inadequate provision (Rs. in crores approx.) | Inadequate provision as % of total increase |
|---|---|---|---|
| Ukai | 54 | 11.6 | 21.5 |
| Ramganga | 91 | 16.4 | 18.0 |
| Beas-Sutlej Link | 86 | 19.0 | 22.0 |
| Jayakwadi | 38 | 3.4 | 9.0 |
| Kallada | 32 | 2.8 | 8.7 |
| Kangsabati | 21 | 1.6 | 7.6 |

131. In Ukai Project Estimate of Gujarat, it is found that inadequate provision in the original estimate was to the tune of Rs. 11.6 crores. To quote some major inadequacies, the cost of earth dam was short by about Rs.4.32 crores due to adoption of low item rates. No provision was made for the removal of stumps in the reservoir area and buildings for work-charged staff which increased the cost by about Rs. 46 lakhs and Rs. 72 lakhs respectively. Share of establishment on this account increased the cost by Rs. 63 lakhs.

Lack of proper planning for diversion work at the stage of preparation of original estimate and tackling the problem of construction in standing pool of water due to Kakrapar weir existing downstream increased the cost by about Rs. 1.76 crores.

An increase of Rs. 1.63 crores is assessed on account of low provision made in the original estimate for distributaries due to adoption of a low rate per acre. Inadequate lump sum provisions in the initial estimate of the left bank canal is responsible for an increase of about Rs. 30 lakhs. The cost of hydroelectric installation increased by about Rs. 40 lakhs as low rates were adopted for concrete around penstocks and inadequate lump sum provisions made for buildings.

132. Inadequate provisions in the original estimate of Ramganga Project of Uttar Pradesh accounted for over Rs. 16 crores. This may be broadly allocated to the different structures as under:

Unit I - Dam & Appurtenant works - Rs. 13.2 crores

Unit II - Headworks, canals & Distributaries - Rs. 2.9 crores

Unit III - Hydro-electric Installation - Rs. 0.3 crore

The rates adopted in the original estimate were based on Rates & Costs Committee's report which were framed on prices prevailing in 1954-55. Moreover, no blasting or ripping of rock to be obtained from borrow area was earlier envisaged. This formed a very small proportion, about 8% of the dam fill which was considered as obtainable by screening the boulders. Later, sand-rock had to be borrowed which involved ripping up of the rock, a costly additional operation not visualised earlier; and the quantity of such rock in the revised estimate constituted 30% of the total dam fill. The original rates were either inadequate or based on inadequate conception of the modes of construction. The increases found necessary to bring up the estimates of dam fill amounted to over Rs. 130 lakhs in the saddle dam and over Rs. 500 lakhs in the main dam. The other major increases were about Rs. 32 lakhs for low rate in tunnelling in bed reaches; Rs. 74 lakhs for not considering items like treatment of bed joints, test sections, instruments, contingencies, etc; Rs. 47 lakhs in the spillway for similar reasons; Rs. 88 lakhs due to a lump sum provision made for stilling basin for tunnel which proved grossly inadequate on detailed estimating.

Under Unit II, there is an increase of about Rs. 68 lakhs due to low provision for cross-drainage works of feeder channels; Rs. 19 lakhs on dewatering & diversion; Rs. 33 lakhs due to inadequate supply arrangement for Afzalgarh canal; Rs. 82 lakhs for remodelling works in lower Ganga canal as well as construction of new structures like regulators, bridges, falls, syphons, etc. found necessary; Rs. 25 lakhs due to inadequate provision made for earthwork for this canal system.

Apart from increase under works, there is an increase of over Rs. 310 lakhs due to low provisions made for establishment and facilities.

133. In Beas Sutlej Link Project about Rs. 19 crores could be allocated to increase due to inadequate provision in the estimate at the initial stage. Shortfalls in hydraulic tests, model studies, survey and investigations accounted for about Rs.44 lakhs. Inadequate rate adopted for excavation of Pando Baggi tunnel was responsible for an increase of about Rs. 130 lakhs in the revised estimate. For the same reason the estimate for Sundernagar-Sutlej tunnel increased by about Rs. 140 lakhs. Low rate for earthwork of Sundernagar hydel channel increased the cost by Rs. 75 lakhs.

The original provision made for cross drainage works of Sundernagar hydel channel was on lump sum basis and proved inadequate. This caused an increase of over Rs. 200 lakhs. The low rate of cement concrete lining of hydel channel brought an increase of Rs.24 lakhs. Inadequate provisions made for escapes, silt ejectors and bridges in hydel channel contributed to a rise of Rs.28 lakhs.

An increase of about Rs. 37 lakhs occurred mainly due to no provisions existing in the original estimate for open cut excavation, drilling & grouting for penstock tunnels. Failure to provide for items like grounding system, power control and other mechanical equipment for the Dehar Power Plant has resulted in an increase of Rs. 26 lakhs.

The lump sum provision made for the Balancing Reservoir proved grossly inadequate and contributed to an increase of about Rs. 250 lakhs. Failure to plan the transmission lines for construction resulted in an increase of Rs.80 lakhs.

No provisions were made in the initial stage for items like fire-fighting, observatories, concrete and soil test laboratories, storage magazine, watch & ward, etc. Subsequent provisions for these items resulted in an increase of about Rs.80 lakhs. Inadequate provisions made for water supply, sewerage and disposal works caused an increase of about Rs.87 lakhs.

The increase due to inadequate provisions had to bear a burden of Rs.138 lakhs as its share for enhanced provision under establishment, tools & plant, etc.

As regards Jayakwadi Project in Maharashtra, it is found that the State Government while according technical sanction to the project estimate, reduced the provisions approved by the Planning Commission under certain heads like Establishment (about Rs.46 lakhs), D-Regulator (Rs.35 lakhs) and B.Land (Rs. 120 lakhs) which were not called for. Land acquisition was approved upto F.R.L. by the Planning Commission which was lowered at the time of technical sanction by the State Government. Provisions made in the original estimate for preliminary works, buildings and miscellaneous items were low (about Rs. 68 lakhs). Some items under earth dam estimate were not considered in the first estimate (Rs.52 lakhs). All these contributed to make the overall estimate sanctioned by the State Government inadequate to the tune of Rs. 340 lakhs.

135. In the Kallada Project of Kerala, the increase due to inadequate provision has been found to be of the order of Rs. 2.75 crores. Of this more than Rs. 75 lakhs is in the dam & appurtenant works where increases made for foundation treatment, spillway and outlet gates, special tools & plant, etc. can be identified as on account of low provision at the initial stage.

Increases found under Unit II Diversion Weir & Canal System on this account total up to nearly Rs. 200 lakhs of which, to mention a few, are absence of any provision for cut & cover for canal, benching of grounds, etc. (about Rs.62 lakhs); low lump sum provision for canal structures (Rs.82 lakhs); etc.

136. Kangsabati Project in West Bengal has not recorded much increase due to inadequate provision at the initial stage. This is so because the project was taken up without any investigation and the modifications made, as it progressed, have been identified mostly as due to inadequate investigation and changes in designs. Out of a total increase of nearly Rs. 21 crores, the increase due to inadequate provision is about Rs. 160 lakhs. Of this, about Rs. 98 lakhs has crept in unnecessarily as recovery by resale or transfer of the Special Tools & Plant has not been considered. The rest of the inadequate provisions have come mostly because the yardsticks usually observed in making provisions under the heads 'Maintenance', 'Tools & Plant', 'Miscellaneous' and 'Establishment' were not observed.

137. Most of the inadequacies in the estimates result from lack of experience on the part of those who frame them. These also occur due to failure in visualising exactly the construction methods and procedures in advance. The result is that there are increases on account of provisions made subsequently for items which could have been reasonably foreseen originally. Inadequacies also result from the practice of making provisions for major lump sum items without any attempt to work out a cost even on a rough basis. It has also been found that provisions for items like establishment, buildings, facilities, etc. are not properly estimated at the initial stage and these at later stages have to be substantially enhanced.

138. In some cases such inadequacies result from failure to allow sufficient time for framing of proper estimates. Sometimes a deliberately over-optimistic attitude in estimation can be traced to pressures from various quarters. The reason behind all such attitudes is the anxiety to get the projects through. Such pressures are perhaps unavoidable in a democracy, specially when the end objective is aimed at welfare of the people. But such tactics are also harmful in as much as these lead to the failure in proper sectoral planning. The enhanced requirement of funds cannot be immediately met and completion of the projects are delayed.

139. Inadequate provisions are quite huge in the giant multipurpose projects of Ukai, Ramganga and Beas-Sutlej Link. The Ramganga project report and estimate was prepared between 1949 and 1958 and approved by the Planning Commission in 1958; Ukai project report and estimate was done up between 1955 and 1958 and approved in 1961; the Beas-Sutlej Link project report and estimate was prepared between 1957 and 1961 and approved in 1963.

The Committee noted that the experience at the early stage of constructing such major projects in a fully mechanised process was not very wide nor was the Himalayan region much known. The Committee also noted that in the present system of strict checking of rates and provisions done in C.W. & P.C. huge inadequacies of this nature would not occur provided the basic information and data furnished in the report are correct.

140. The attitude of making inadequate provisions in the estimates entails a greater responsibility on the part of those who are concerned with the scrutiny and approval of these schemes. They have to identify the deficiencies and rectify the inadequacies in the estimates.

141. The Committee feels that there is a case for exercising more care in framing the estimate by those concerned with its preparation, as also those who check it. Advantage may be taken of the finalised cost figures incorporated in the completion reports of already executed of project. In this context the Committee strongly recommends that the preparation of completion reports which has not been given adequate importance in the past should now be insisted upon to be finalised within two to three years of commissioning the projects.

# 11. COST ESCALATION DUE TO CHANGE IN SCOPE

## 11. COST ESCALATION DUE TO CHANGE IN SCOPE

142. Instances are not rare where the scope of a project has been increased during the course of construction. Such changes in scope may be in the form of increase in area to be irrigated, increase in power generation capacity or increase in flood control benefits. This naturally adds to the cost.

143. The estimated cost of Mahanadi Delta Project in Orissa increased from Rs. 14.92 crores to Rs. 68.38 crores showing an increase of about Rs. 53.46 crores. Of this, about Rs. 8.76 crores which is over 16% of the increase, could be identified as on account of change in scope of the project. This comprised–

| | | |
|---|---|---|
| (i) | Provision for irrigation in Doab between Chitrotpala through Nuna & Mahanadi (i.e. Stage IC) | = Rs. 607.00 lakhs |
| (ii) | Devi-Kandal and Devi-Taunla Canals | = Rs. 154.19 lakhs |
| (iii) | Flood protection works | = Rs. 105.30 lakhs +<br>Rs. 9.82 lakhs |
| | | Rs. 876.31 lakhs |

The Stage IC of the scheme was initially to be treated as an independent medium project but later on taken as a part of the Delta project in course of its second revision. Similarly, Devi-Kandal & Devi-Taunla Canals were not contemplated earlier and represent change in scope. Flood Control Works were not a part of this scheme initially but were subsequently included in the Delta Project as per orders of the State Government.

When this project lingered for 13 years since its approval by the Planning Commission in 1957, the Government of Orissa set up an Enquiry Committee in May, 1970 which, amongst other things, was asked to make suggestions for a speedy completion of the project in stages, so that maximum irrigation benefit becomes available with minimum investment per year. It would be interesting to note that in its recommendations submitted to the State Government in January, 1972, the Enquiry Committee recommended inter-alia (i) to defer the extension of irrigation covered in Stage IC mentioned above,

(ii) to omit the Devi-Kandal and Devi-Taunla Canals and (iii) to transfer the flood protection works to the flood sector as the cost involved was not considered to be a correct charge to irrigation. In other words, all the additions made to the original estimate by way of changing its scope have been recommended to be either deferred or dropped or transferred so that the project may still be completed in 1977 (i.e. 20 years after its approval by the Planning Commission).

144. Ramganga Project in Uttar Pradesh showed marked increase in cost due to change in scope of the project after its approval by the Planning Commission. The increase is over Rs. 11 crores and represents about 12 % of the total increase of about Rs.91 crores. As against the stipulation of 13.00 lakh acres of area to be irrigated in the 1958 report, it is proposed to irrigate an area of 16.28 lakhs acres as per the latest report. This necessitated major changes in the remodelling of existing canals and structures and construction of new channels. The installed capacity of the power house has increased from 105 MW in 1958 proposal to 198 MW in 1971. It is now proposed also to supply 200 cusecs of water to the Delhi Administration which was not stipulated in the 1958 report.

145. There is an increase of about Rs. 330 lakhs on account of change in scope of Ukai Dam Project in Gujarat which is about 6% of the total increase of Rs.54 crores in the revised estimate. This has mainly resulted from the revised concept of increasing the peaking capacity of the system by increasing the installed capacity from 160 MW in the original estimate to 300 MW in the revised estimate and operating at 35% load factor instead of at 60% assumed initially. A small increase (Rs. 7 lakhs) was for the essential works of a small power house at left canal head to be constructed at a future date.

146. From 1958 to 1969 the estimated cost of Gandak Project in Bihar rose from Rs. 40.42 crores to Rs. 108.18 crores showing an increase of Rs. 67.76 crores. In the 1958 estimate there was no provision for the construction of Ghorasahan and Dhanaha Branch canals which were later added at a cost of Rs. 372 lakhs and Rs.45 lakhs, respectively to bring an additional area of over two lakh acres under irrigation. Thus the change in scope increased the approved cost of the project by Rs.4.17 crores.

In this connection a few other projects in which changes in scope subsequent to their approval have been noticed may also be mentioned in brief.

147. Kabini Reservoir Project in Mysore was sanctioned in 1958 for irrigation of 30,000 acres. In the revised report of 1969, this has been raised to 1,85,000 acres. In addition, provision has been made for generation of 32,000 kW of Hydro-power and supply of 2,800 million cu.ft. of water to Bangalore city. For this purpose the capacity of the reservoir has been increased from 12,000 million cu.ft. to 19,200 million cu.ft.

148. Another project in Mysore, Upper Krishna Stage-I was approved in 1963 when the irrigable area was shown as 6 lakh acres. In the 1970 revised report, the irrigable area has been increased to 10.10 lakh acres. This has been possible by reducing the loss of water by providing lining to canals and distributaries and changing the cropping pattern.

149. Rajasthan Canal Project was approved in 1957 for a proposed annual irrigation of 16.84 lakh acres which, in the revised 1969 report, has been enhanced to 31.24 lakh acres. Lining of the main canal increased the availability of water which made possible perennial irrigation of a much bigger area and thus increased the scope of the project. This enlargement correspondingly necessitated an increase in the lengths of branches and distribution systems to utilise the water saved from loss.

150. Pamba-Irrigation Project in Kerala was sanctioned in 1964 for irrigation of an ayacut of 33,000 acres. In the revised report of 1972 this has been increased to 44,000 acres by increasing the crest level of the weir and the capacities of the right and left bank canals.

151. Another project in Kerala, the Chitturpuzha Irrigation Project was approved in 1964 to provide irrigation to 27,800 acres. In the revised report of 1971 this has been increased to 42,700 acres.

152. There may not be any objection in principle, to the change in scope, provided the incremental cost is justified vis-a-vis the next best available alternative. There is, however, serious repurcussion of this change. Because of increased scope, the cost goes up and the entire planning of resources is thrown out of gear. Whether to agree to the changes in scope has to be decided taking into account the economic constraints - availability of funds and resources in the context of overall planning. The Committee, therefore, feels that on this consideration changes in scope may be avoided and projects should be more comprehensively planned at the early stage by placing in charge of investigation and project formulation, experienced and competent technical personnel. Such changes in scope may be allowed in situations where, by not making changes in the project features, the chances of effecting increase in scope are permanently jeopardised. In case, such changes have to be accommodated after the approval of the project, the additional works should, wherever possible, be sanctioned as separate schemes whose costs have only to be arithmatically added to the earlier project to find out the total cost. This would guard against avoidable criticism of excessive expenditure for the project. When it is not possible to bring up a separate scheme for the change in scope, the estimate of the project with the increased scope should be sanctioned as a "modified project" and not merely as a revised estimate.

# 12. COST ESCALATION DUE TO CHANGE IN DESIGN AND ADDITIONAL REQUIREMENTS

## 12. COST ESCALATION DUE TO CHANGE IN DESIGN AND ADDITIONAL REQUIREMENTS

153. Because of the complex nature of river valley projects, all the items and requirements cannot be visualised at the stage of preparation of the feasibility report (project report submitted for approval of the Planning Commission), however adequate the investigations may have been. Feasibility reports are based on broad designs for major features. Some changes take place at the detailed design stage which follows vigorous and detailed design studies. These may come due to adoption of changed design criteria, modification of lay outs, going for a better specification of works and so on. One has, therefore, to reckon always with some increase in cost on account of these changes.

154. In case of headworks i.e. structures like dams, spillways, barrages, etc. even when adequate investigations have been done, some problems, not anticipated, often arise after opening of foundations which call for lowering of foundation level or special treatment of the foundation or other changes in design and specifications of the structure.

155. In the distribution system structures required for hundreds of miles of canals cannot be designed and estimated fully at the initial stage. The provision for such structures is generally based on parametric estimates making use of cost graphs worked out from statistical analysis of past projects. It is also done on the basis of typical estimates of representative structures. It is only obvious that at the detailed estimation stage of each and every structure there would be variations in costs.

156. Investigations for tunnels and other underground works are based on regional geology; a few bore holes drilled along tunnel alignment cannot altogether obviate the possibility of surprises in actual construction. This is more so in case of long tunnels and tunnels located deep under the strata where it is extremely difficult to drill very deep holes over 1000 ft. Methods of tunnelling have sometimes to be drastically changed to tailor them to the requirement of strata encountered during boring. The unknowns and hence the risks involved are far more than works in an open pit. Engineers

have to find solution to various problems as they are met with during construction like tackling highly water charged strata, boring through geologically adverse tunnelling zones, etc. All these cannot be visualised and estimated accurately in terms of cost at the original stage.

157. Power House structures, when built overground have the same problems as the headworks. When underground, they suffer from the same drawbacks as the tunnel. Apart from these, there are numerous small items which are properly estimated only at the detailed design stage like water & sanitary pipes, air conditioning system, metal works, finishing of floors, architectural treatment, etc. Power House structures have often to bear substantial cost increase on this account.

158. To cover all this cost increase which would invariably occur in such projects an additional provision should be made in the estimate under a head which may be called "Margin of error".

159. The percentage increase due to changes in design and additional requirements over original cost of works, noticed in the revised estimates of projects examined, may be seen from the table below.

| | £/ Increase as % of original cost | | | | | |
|---|---|---|---|---|---|---|
| | Ukai | Beas-Sutlej | Jayakwadi | Ramganga | Kangsabati | Kallada |
| 1. Unit I Headworks | 10 | (-) 2 | 4 | 3 | (-)18 | 15@@ |
| Tunnels | - | 30 | - | - | - | - |
| 2. Unit II-Canals | Nil@ | | 6 | 28 | 6* | 8* |
| Distributaries | NA | | NA | - | 53** | Nil@ |
| 3. Unit III-Hydro-electric installations (Civil Works) | 48 | 50 | | (-)83 | | - |

£/ Original cost adjusted for increase due to inadequate investigation and inadequate provision.

@ Work not taken up.

@@ Negligible work done.

* Addition of canal lining.

** Extension of channels from 5 cusec to 1 cusec discharge.

NA Not available.

The Committee observed that the increases and reductions on account of change in designs recorded from the examination of project estimates were not very consistant and as such did not help in arriving at the "Margin of error" which the Committee wished to recommend. This has happened because the projects were taken up without adequate investigations and there was enough scope to modify the designs or layout of headworks to effect savings beyond expectations. In the case of canal and distribution system, the work has either not been investigated yet or not been taken up or the figures are not available due to adoption of overall average rates. Moreover, extension of channels upto one cusec discharge or 100 acre block for which increases have occurred should not happen in future as all channels will have to be taken down to 100 acre block.

160. The Committee after detailed discussions recommend on the basis of their experience the margin of error indicated hereunder. This recommendation is made on the premise that the preliminary designs are based on adequate investigations done at the initial stage.

For specifying any limits for 'margin of error', the works should be divided into following groups:

1. Headworks
2. Tunnels & other underground works
3. Distribution

### Margin of error for Headworks

161. Margin of error for headworks would be of the order of 10 to 15% between the estimate prepared at the feasibility report stage and that prepared at the stage of detailed project report.

### Margin of error for Tunnels

162. Because 'unknowns' in a tunnel job are more, the margin of error is likely to be more. In tunnelling work the margin of error would be of the order of 30 to 40%. This is for work in the Himalayan region particularly.

## Margin of error for Distribution Systems

163. The distribution system can be divided into four groups:

1. Primary System (consisting of Main Canals and Branches)
2. Secondary System (consisting of Distributaries & Minors)
3. Tertiary System (consisting of Minors and Water courses)
4. Quaternary System (consisting of Field Channels not belonging to Govt.).

For primary system, full surveys for the L-Section right upto tail end should be done. Surveys should be done for all major structures in the system. For small structures, these should be identified and provisions made on the basis of parametric estimates. 'Margin of error' for estimates for such works would be 10 to 15%.

For secondary system, provisions are to be based on surveys of two/three typical distributaries. Because of fewer samples adopted for assessing the cost, the margin of error is comparatively large. This may be of the order of 20 to 25%.

For tertiary system, provisions are to be based on typical surveys on area basis. The margin of error for this may be 25 to 30%.

## Margin of error for Hydro-electric Installations (Civil Works)

164. This work is prone to a lot of design changes after detailed investigations and numerous items are added at the detailed estimating stage. The 'Margin of error' for this work would be 40 to 50%.

165. One important factor in the formulation of irrigation projects is drainage. It is essential that along with the preparation of the feasibility report for a project, a feasibility plan for drainage should also be made available and the cost thereof provided in the estimate. A 'margin of error' of 20 to 40% is suggested in connection with the estimates for drainage. This margin would be on the lower side for alluvial soils and high in case of other

classes of soils requiring more drainage. In this connection, it is suggested that C.W. & P.C. should prepare and issue guidelines for investigation of drainage part of the schemes.

166. It is felt that with more and more experience in the construction of major river valley projects, it would be possible to reduce progressively the 'margins of error'. For this purpose it is recommended that the margins of error obtaining for different types of works should be constantly studied and periodically reviewed for adoption of any revised standards in future.

# 13. COST ESCALATION DUE TO OTHER CAUSES

# 13. COST ESCALATION DUE TO OTHER CAUSES

167. In the previous chapters attention has been focussed at identifying the principal causes of cost rise and delay and finding out ways and means by which these could be rectified. There are other factors which also lead to the cost rise. Four of these causes which are quite important are being reviewed in this chapter and suggestions offered for their remedy. These are:

1. Increase in land rates,
2. Increase owing to rehabilitation measures,
3. Paucity of funds, and
4. Poor performance of equipment and procurement problems.

## Increase in land rates

168. The phenomenal increase in land prices is throwing out the estimates and has become a very troublesome trend vitiating economic construction of irrigation and multipurpose projects. At the time of preparation of original estimates, the land prices, as per usual practice, are adopted mostly in consultation with the Revenue authorities. These estimate rates are based on current transactions. The Committee has noticed that rates actually settled by awards have gone up very high.

169. In the Jayakwadi project, Maharashtra the rate of land going under submergence in the reservoir area was taken in the original estimate at Rs.500 per acre which, due to higher award went to Rs.1155 to Rs. 2835 per acre. The rate of land in canal alignment went up from Rs.400 per acre to Rs.1500 per acre. In Ukai Project, Gujarat, the rate of land adopted in the original estimate ranged from Rs.200/- to Rs.450/- per acre. In the revised estimate these have gone up between Rs.600 to Rs.960 per acre. The rate of cultivable land in Ramganga Project, U.P. increased from Rs.700 per acre in the original estimate

to Rs.2000 per acre in the revised estimate. In the Kangsabati project of West Bengal, the rate of cultivated land was taken at Rs.1000 per acre in the original estimate which went up to Rs.2500 per acre. In Kallada project, Kerala, private dry land was originally provided at Rs.1000 per acre and private wet land at Rs.3000/- per acre. These, in the revised estimate, increased to Rs.3040 and Rs.5050 per acre, respectively; while private land required for canals and distributaries shot up from Rs.5000 per acre to Rs.12,140 to Rs.24,280 per acre.

170. This tremendous increase in the prices of land has told on the costs of projects very badly. The table below indicates the rise in cost on this account in the projects examined by the Committee. The story is not likely to be different in other projects.

| Project | Original provision (Rs. in lakhs) £/ | Increase due to higher awards (Rs. in lakhs) | % Increase over original provision |
|---|---|---|---|
| Jayakwadi | 674 | 845 | 125 |
| Ukai | 373 | 339 | 91 |
| Kallada | 228 | 754 | 330 |
| Kangsabati | 258 | 287 | 112 |
| Ramganga | 112 | 213 | 190 |
| Beas-Sutlej Link | 72 | 58 | 81 |

£/ Original provision adjusted to take into account the requirements of land subsequently added.

171. The Committee has come across instances where execution of projects was also delayed due to delays in land acquisition. The procedure involved is long and time taking. Delays in acquisition of land result in higher land rates because of speculation. There is need for streamlining the

procedure for land acquisition. This, it is observed, has already been dealt with by a Land Acquisition Review Committee which was set up by the Government of India. The Review Committee has already made certain recommendations which have been endorsed by the Irrigation Commission. The relevant portion from the Irrigation Commission's report (Vol. 1; p. 297) is reproduced below:

> "12.53 Recently, the Land Acquisition Review Committee set up by the Government of India to examine the provisions of the Land Acquisition Act of 1894 has recommended:
>
> i) the setting up in each State of a Directorate of Land Acquisition under a Member of the State Revenue Board, which would be responsible for land acquisition;
>
> ii) a regular monthly review of progress at the Collector's level;
>
> iii) adequate pre-planning for the acquisition of land required by projects and the issue of notifications specifying the project areas. These notifications would be valid for two years within which period the land would have to be acquired;
>
> iv) prescribing time limits for the Directorate of Land Acquisition to complete acquisition proceedings; and
>
> v) special powers to deal with specific emergencies."

The Committee endorses the recommendations made by the Land Acquisition Review Committee and trusts that they will expedite the acquisition of land. The Committee feels that it would further help if exclusive posts of special land acquisition officers are earmarked for major projects so that they can give their undivided attention to the project work.

172. The Committee within the short time at its disposal could not examine any details concerning land deals and awards with a view to ascertaining reasons for high rates. It, therefore, recommends that a Central Committee consisting of concerned officials may be formed and assigned the task of evolving a standard approach for adopting the rate of compensation for land

which would recognise (i) a fair deal to those affected and (ii) prevent any artificial increase in the cost of land. This has particular relevance to projects whose benefits go to one State, while land has to be acquired for areas going under submergence in a neighbouring State.

## Increase owing to rehabilitation measures

173. The construction of reservoir projects brings in its wake the displacement of numerous persons from their hearths and homes. In the early stages of planning and construction, the usual practice was to pay these displaced persons the value of their land and property acquired by Government with an additional 15% as solatium for acquisition of land compulsorily.

174. In course of time the idea developed of rehabilitating the persons thrown out suddenly from their homes and livelihood. This, it is presumed, has been found necessary because of two reasons. First, the compensation paid gradually proved inadequate to purchase the same quantum of land and property and secondly the village folk not been accustomed to handle any big money, lost in no time the cash compensation paid to them and were ruined.

175. The rehabilitation measures include (i) giving agricultural land to the displaced persons, (ii) making arrangements for their housing; (iii) shifting and transporting the affected persons and (iv) providing amenities like approach roads to new colonies, water-supply arrangements, recreation centres, schools, hospitals, houses of worship, etc.

176. What the Committee has observed in the projects examined is indicated in the table below:

| Project | Provision made for rehabilitation (Rs. in lakhs) | No. of persons affected | Provision per capita worked out to (Rs.) |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Jayakwadi | 33 | 45,000 | 73 |
| Ukai | 121 | 61,900[a] | 195 |
| Kangsabati | 9[b] | - | - |

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Kallada | 1[c] | - | - |
| Beas-Sutlej Link | 20 | 2,000[d] | 1000 |
| Ramganga | Nil[e] | - | - |

[a] Considering 5 persons per family. No. of families indicated is 12,380.

[b] Arrangements for rehabilitation of the displaced persons were initiated. Construction of hutments with ancillary amenities were partly completed. About 10% of the displaced persons shifted to the area. But the rest declined to take advantage of the arrangements made for rehabilitation and preferred cash compensation.

[c] In Unit I, provision of Rs. 10,000 has been made for 40 families. Considering 5 persons per family, the per capita provision would be Rs. 50. Basis of provision in Unit II (Canals) is not known. It is stated in reply to questionnaire that so far, there has been no necessity of making any arrangements for rehabilitation as the oustees who got the land value, made their own arrangements for resettlement.

[d] Considering 5 persons per family. No. of families indicated in the first estimate is 400.

[e] Rehabilitation problem does not exist in the project.

It would be seen from the foregoing table that per capita provision on rehabilitation is different in different States.

177. In this connection, efforts were made to collect information independently from various States and projects about the rehabilitation measures adopted and the amenities provided to the persons displaced on account of

acquisition of their land and property for the construction of river valley projects. Replies received from 10 States and projects have been compiled vide Appendix 9 to this report. The position is broadly indicated in the following paragraphs:

## Land for Agriculture

There is no uniform practice in this regard. Some States do not provide for any land to the oustees. In some other States, (M.P., Andhra Pradesh) land for land is given if available. In Andhra Pradesh, in case of Srisailam & Pochampad projects, land is to be given free of cost in lieu of land acquired subject to a prescribed ceiling. In Orissa (Balimela Project) & Mysore, land is acquired from forest and other sources for resettling the persons displaced as a result of construction of projects and allotted to them subject to a ceiling. The cost of reclaiming such land is borne completely or subsidised by the project. Oustees at Beas Project are to be allotted land in the Rajasthan Canal Project area.

In Mysore, land for cultivation is given free of cost to tenants and agricultural labourers.

## Housing

At most of the projects, land is acquired by Government to establish villages for resettlement of displaced persons. This covers the requirement of land for houses, roads, temples, community halls, recreation centres, Gaothans, burial ground, etc. The quantum of land to be allotted per family for building the houses is not uniform. In some States & Projects (Andhra Pradesh & Beas), allotment on reduced scale is made to landless displaced persons. In Bihar (Tenughat Project), while the land acquired from forest & other waste land is given free, the displaced persons excepting the landless ones, have to pay for the cost of tenancy land acquired for them.

In Balimela, Beas, Srisailam & Pochampad projects, displaced persons not migrating to the rehabilitation centres established by the Government, are to be given lump sum rehabilitation grants for house building the quantum of which varies from project to project.

## Shifting Charges

In most of the States and projects, displaced persons are either given cash allowance or provided with Government transport for shifting their personal effects & salvaged material from the acquired property. In Madhya Pradesh however there is no such practice. In Maharashtra & Mysore the practice is to allow the persons affected to take free of cost the materials which can be salvaged from the acquired property. In Tamil Nadu (Parambikulam Aliyar Project), this material is given at a concessional rate of 25% of the cost.

At Beas & Tenughat projects, temporary shelters are provided at project costs near the rehabilitation sites or transit camps to enable displaced persons to construct their houses or to proceed to the settlement areas.

Amenities:

In almost all States and projects (excepting Madhya Pradesh), arrangements are made for approach roads, internal roads, water supply (wells, tanks), community halls, schools, temples, Gokatte, electric lighting, etc. in new villages or rehabilitation centres constructed for resettlement of oustees at project cost. There appears to be a fair uniformity in this respect.

178. The Committee finds that there is no uniform policy laid down as regards the scale of rehabilitation measures. Standards followed in each State are different. The issues get very complicated when a project is located in two States and the question of compensation to be given to the people of one State by the other on this account crops up. The Committee recommends that a broad national policy on rehabilitation should be laid down with provisions for reasonable modification being permissible on the merits of each case.

179. Irrigation and multipurpose projects are economic and quasi-commercial ventures. It is, therefore, the Committee's view that once full compensation has been made for the land and property acquired, any additional expenditure incurred towards creating a new and better environment for those displaced on account of construction of the project is purely on social and welfare considerations and is not a proper charge to construction. The Committee recommends that although there may not be any alternative but to charge this to the project cost, it may be excluded for benefit-cost analysis.

Paucity of Funds

180. It is noticed that paucity of funds has held up progress on certain projects. This has resulted in prolonging the construction period and

consequently delaying the realisation of benefits. The table below gives in brief the position found from the examination of the project estimates and the information furnished by the project authorities in reply to the questionnaire issued to them.

| Project | Estimate | | Period of construction & completion | |
|---|---|---|---|---|
| | Original (Rs. in crores) | Revised (Rs. in crores) | Original | Revised |
| 1. Kangsabati | 25 | 46 | 5 yrs. (April, 1956 to March, 1961) | 20 yrs. a/ (1956-76) |
| 2. Kallada | 13 | 45 | 10 yrs. (1966-76) | Not framed b/ |
| 3. Jayakwadi | 36* | 74 | 7 yrs. (April, 1964 to March, 1971) | 15 yrs. c/ (upto March, 1979) |
| 4. Beas-Sutlej Link | 94@ | 180 | 10 yrs. (1963-72) | 12 yrs. d/ (upto 1974) |
| 5. Ukai | 55@ | 109 £/ | 6 yrs.** (August, 1961 to August, 1967) | 15 yrs. e/ (upto June, 1976) |
| 6. Ramganga | 40 | 131 | 7 yrs. (April, 1958 to March, 1965) | 16 yrs. e/ (Civil Works by June, 1974) |

a/ The programme of expenditure made for the Third Five-year Plan was for Rs. 15 crores. Against this, the Plan provision was only Rs. 8.07 crores. For want of adequate funds, it had not been possible to frame any programme for the completion of the various Units.

b/ The schedule for completion of the project could not be prepared due to uncertainty about the availability of funds. The expenditure incurred till 1971-72 was about Rs.2.27 crores.

* Sanctioned by the State Government.

c/ Paucity of funds has delayed the acquisition of land and the construction of the project. As against about Rs.56 crores asked for from 1965-66 to 1972-73, the funds allocated amounted to about Rs.33 crores.

@ Exclusive of Transmission System.

d/ Due to paucity of funds, the work could be started only in 1964.

£/ Indicated in Annual Plan discussion.

** For headworks and canals.

e/ Availability of funds was not a problem in this project and the delay in construction is due to other reasons.

181. It would not be correct to assume that the periods of completion indicated in the original reports of the projects were realistic. More often than not they were too optimistic and not related to what was physically achievable. Even then, the fact remained that non-availability of adequate funds has had a stranglehold on some of the projects and failed them to come up within a reasonable time.

182. What appears to be happening is that the cost of schemes increase and the Government is unable to provide adequate additional funds for the projects. The resources thus get spread too thin. The effect of inadequate financing is that the projects go on languishing and lingering and costs increase enormously because of inflation in prices.

183. The Committee feels that to relieve this situation a two pronged approach is necessary. First, the projects should be planned in phases and taken up phase by phase. This will reduce pressure on the financial resources of the country but make the financing of projects more effective. Physical phasing should be done in a manner which optimises the flow of benefits from large projects. The storage dam may be raised in two or three stages after the first construction. The programme of digging canals and adding more units for generation of power should closely follow the pattern of development. At the same time, continuity in construction should be maintained uninterruptedly. Such scientific phasing will ensure economic utilisation of the capital and equitable distribution of projects in the country.

184. Secondly, the financial phasing must be made to match the physical phasing. Once a project has been approved by the Planning Commission, funds should be made available fully for its execution. Whether adequate financial resources would be available has to be thought out in advance and planning of resources would have to be done before sanctioning a project.

185. Good performance in the Indian economy during any year is still very much dependent on favourable monsoons. In order to acquire reasonable immunity from the vagaries of this natural factor, it is imperative that in allocation of financial resources, irrigation and multipurpose projects receive very high priority and substantial funds so that all projects approved by the Planning Commission are completed in optimal time and further escalations in costs are avoided. High priority for irrigation projects is also called for when one looks at the problem from another angle. Because of shortage in food production, the country has to import very substantial quantities of food from abroad to meet the demand during the scarcity years. This involves huge amount of foreign exchange which the country can ill afford to spend. Moreover, one of the main flanks of the agriculture strategy adopted for increase in food production is to go for high yielding variety seeds. Such seeds require assured irrigation and unless water is supplied, the strategy is not going to succeed. Irrigation projects should, therefore, get an overriding priority in the matter of allocation of financial resources. This would also lead to the contribution of a stablising factor in the economic growth, providing immediate avenue for large-scale employment as well as ushering in early benefits of assured supply of water for dependable agricultural production and growth of electricity which in turn would create further job opportunities on a permanent basis.

## Poor performance of equipment & procurement problems

186. The Committee in course of its enquiries heard repeated complaints from the project authorities about the poor performance of indigenous construction

equipment, indifferent behaviour of supplier firms and procurement policies which are not conducive to efficient execution. Some of these complaints

i) Delay in supply of heavy earthmoving equipment and spare parts by the indigenous manufacturers. The suppliers do not stick to the dates of deliveries which are extended on one pretext or the other. The spare parts are not supplied adequately with the machines.

ii) As more and more indigenous equipments are coming to the project, it is seen that their availability to works is hardly 40 to 50% even when the equipments are new. The breakdowns are excessive. Due to weak metallurgy, the wear & tear is faster and the overhaul of machines is called for earlier than the imported ones. The engines of some of the indigenously manufactured machines had to be opened out within hardly 1,000 hours of working. The firm also failed to supply spares as a result of which their operation had to be suspended for months.

iii) Certain models of indigenously manufactured tractors which were supplied in 1969 have already been declared obsolete by the manufacturers in 1972. The performance of this equipment has been very poor.

iv) Very poor quality of spares like filters, rectifiers, brake lining and propelling chains, have to be necessarily obtained from indigenous sources, as imports for such items have been banned. Sometime after trial and error, when indigenous parts failed to work, import was allowed after long delay. General complaint is that import of these items has been banned while indigenous capacity to manufacture such items is yet to develop fully.

v) Time required for obtaining imported spares is too long. It takes two to three years normally to obtain them.

vi) Some firms which had entered into rate contract for certain items avoided the supply of these items when indented. The reason for such evasion can be traced in the fact that the prices of such items in the open market were very much higher than those specified in the rate contract.

187. The direct effect of delays in supply of equipment and spares is obvious. These have indirect effects also. Because of uncertainties in supply of these items, there is a tendency to over indent. Sometimes due to non-availability of proper spare parts, attempts are made to cannibalise the machines or to have make-shift arrangements with poor substitutes. The effect of all such stop-gap arrangements is reduced efficiency and cost hike. In some cases, non-availability of spares for certain types of equipment, apart from adding to idle depreciation, held up a number of other sequential operations which were dependent on the working of the particular equipment.

188. It is not possible to get away from the fact that indigenously manufactured earthmoving equipments are still not of sufficiently dependable quality. This is perhaps unavoidable when the industry is in its infancy. As the machines are sick too often, their out turns fall short of the schedule which is prepared on the basis of performance of the imported equipment. Thus the targets cannot be fulfilled, the construction gets delayed and the unit costs are pushed up. One has, therefore, to make a realistic assessment as regards output of such equipment while estimating the unit costs. The Committee recommends that studies in this regard may be carried out by C.W.& P.C. who may lay down norms in this connection.

189 There is a case for exercising pressure on the manufacturers of indigenous equipment which are in both private and public sectors for giving better service to their customers. The Committee suggests that the Ministry of Irrigation and Power may take necessary steps in this regard at the highest level.

# 14. MANAGEMENT OF WATER RESOURCES PROJECTS

# 14. MANAGEMENT OF WATER RESOURCES PROJECTS

190. One of the main tasks assigned to the Committee was to examine the existing arrangements for the framing of construction programmes and to recommend improvement in the present system of implementation of projects to ensure their completion within the estimated costs and according to the scheduled programmes of completion. The Committee examined in detail the management factors involved in the execution of the river valley projects. It also discussed with the project authorities about the bottlenecks created by poor management at technical levels. The examination revealed that there were lacunae and shortcomings in almost every sphere of the project execution which had a great bearing on timely and economical completion of projects. There is pressing need to effect improvements in the various fields of management such as organisation, programming, selection of agencies for execution, material and equipment planning, cost control, etc. The findings of the Committee on various such topics and the remedial measures suggested to improve the situation are dealt with in detail in the following paragraphs.

## Organisation

191. A basic ingredient as important as all others in implementing an irrigation or multipurpose project is an organisation structured to attain the desired objective. At present, a number of organisational patterns are being tried in the country. The execution of some of the major projects is under the overall direction of Control Boards set up for the purpose. Control Boards are constituted usually with the Chief Minister of the State in which the project is located as Chairman and the Finance and Irrigation & Power Ministers of the State, representatives from the Centre, Secretaries of the concerned departments, and the Chief Engineer as Members. The Board, being a high-powered body, is expected to take quick decisions on various administrative, financial and technical matters relating to the execution of the projects and thus ensure their speedy completion. Some projects have single administrators looking after them. The majority of projects are, however, being executed as per the normal pattern of working in the Public Works Departments where all decisions are taken after processing a case through usual Government channels. Such a pattern invariably suffers from delays in decision making and is not conducive to speedy execution of the projects. Such delays prove extremely harmful specially when the projects involved are major and the stakes large.

The recommendation of the Irrigation Commission, 1972 on this aspect is reproduced below:

> "A large irrigation project involves many different activities and it is essential not only to co-ordinate the activities at the site but also those involving the departments of the State at headquarters. Such co-ordination is even more important in inter-State projects. To handle the many problems of co-ordination involved in construction, Control Boards have been set up in many projects.
>
> We consider that all large inter-State projects and any State project costing Rs. 500 million or more should have a Control Board. Even for projects costing less than Rs. 500 million but which are of a complicated nature, a Control Board would be desirable. To be effective, Control Boards should be delegated the maximum powers and should in turn, be liberal in delegating powers to the Chief Engineers of projects in the interests of efficiency.
>
> In States where several projects are under construction, a single Control Board with standing committees for each project would suffice. This would help to promote the best use of man-power and equipment.
>
> Where a major project receives special financial assistance from the Union Government, the centre should be adequately represented on the Control Board."

The Committee endorses the views and recommendations of the Irrigation Commission for acceptance for the construction of irrigation and multipurpose projects.

192. Usually, the project organisation is headed by a Chief Engineer, and in some cases by a General Manager, who is given the charge of execution of the project. There are also major projects which are not looked after exclusively by a Chief Engineer who, in addition, has to supervise and control construction and maintenance of other works in the State. The Committee is of the view that execution of a major project is a full-time job and requires the single-minded attention of the Project Manager, who should be divested of all other assignments in order to enable him to devote himself fully to the construction of the project. It, therefore, recommends that for a major river valley project there must be a Chief Engineer or a Project Manager posted exclusively for its execution.

193. It is not always that a Chief Engineer has the necessary amount of authority to enable him to execute his assignment efficiently. The Committee wishes to emphasise the point that for any Programme to succeed, it is essential that the person in charge of execution is granted appropriate authority, both administrative and financial, so that he may discharge his responsibilities unhesitatingly. There is thus a very cogent case for delegating more powers

to the Chief Engineer/Project Manager even when there exists a Control Board for overall direction as regards planning and execution. In this connection a scheme of delegation of powers for major irrigation and power projects formulated by the O & M Division, Government of India in 1963 need to be reviewed, taking into account the problem faced on various projects. For this purpose, the Committee recommends that a team of officials including technical officers from various projects in the country, may be set-up to go into this question and draw up a model for adoption in the projects to be taken up in future.

194. The Committee in course of its enquiries have come across instances of high rate of staff turn-over in the project management. During its investigations, the Committee noticed that in a major and complex project, there were four changes of chief project executive in three years' time. In a complex multipurpose project, it is likely to take six months or even a year for a person to comprehend fully and familiarise himself with the project itself and before he is ready to exercise authority and bring his expertise to bear on the project, he finds himself transferred. This adversely affects the expeditious and efficient execution of the project. There is, therefore, a need for greater continuity. The Committee is firmly of the view that there should not be too frequent changes in the key personnel entrusted with the execution of the project.

## Project Management

195. The history of irrigation projects planned and executed in the modern era is fairly old in this country. In fact, some of the classical irrigation systems in the country were conceived and executed around the middle of nineteenth century. Since then a number of civil engineering works were constructed throughout the length and breadth of the land. As a result there was development of expertise in the field of civil engineering. The country produced some very brilliant and talented engineers during the early part of this century. They were responsible for initiation of big water resources projects before the country attained independence and immediately thereafter.

196. It was only after the dawn of independence that in the context of planned development of the country, irrigation and multipurpose projects were launched in a big way on a scale which was unknown in the past. Some of these projects were so huge and complex, that these could pose to be very challenging tasks even for countries with very advanced levels of technology. In terms of number of projects being executed there has been manifold increase compared to whatever was done before independence. For construction of projects of such magnitude in such a large scale attempted for the first time, there was no previous experience to draw upon. The result has been that management on many projects left much to be desired.

197. Management of river valley projects is quite a complex job. The project managers have to be well conversant with the modern management methods in order to exercise effective control over all aspects of the project execution. They have to increasingly handle problems connected with personnel, labour turnover, welfare, industrial psychology, etc. and more so, when projects are labour intensive. At present there is no attention given to this aspect. Persons put in charge of execution of projects are service officers who have never been exposed to modern management techniques. The Committee feels that for a successful implementation of the development programmes, there is a strong need to have a more professional approach to the task and have competent project managers. It recommends that in order to create a nucleus of such experts, senior technical officers, who show an aptitude for project management are earmarked for special training.

Apart from project managers, all officers - engineers, geologists, accountants, planners and managers (Specially material managers) who are engaged in project works, should have good bit of training in the water resources sector. They should be trained in the same Institute with a good deal of common courses so that they develop outlooks with common objectives. The Committee recommends that a comprehensive institute should be set up for the purpose in the Centre and preferably in C.W. & P.C. At the State level also there should be training facilities in the water resources sector for junior officers of the rank of supervisor, junior engineer, etc. The Committee further recommends that existing facilities like Water Resources Development Centre at Roorkee and Administrative Staff College at Hyderabad should be utilised fully till such time a comprehensive institute at the Centre for training in water resources sector comes up.

198. The present day water resources projects, particularly the complex ones, suffer from the same management problems as one encounters in large industrial undertakings. Unless these are tackled in a scientific manner, delays and cost increases are bound to occur. There has been, in recent years, a rapid development in the rationalisation and improvement of management methods in the context of Defence and Space projects in U.S.A. and other advanced countries. These methods could be fruitfully used in case of water resources projects in the country. In essence, these methods are based on the "System" approach to the entire question of project management and control where, by comprehensive planning of all activities involved in various phases, mobilising all resources, exercising effective co-ordination between the various executing agencies and having systematic monitoring arrangement for watching the progress of works, speedy and economical implementation is aimed. The Committee strongly advocates the use of all the modern management techniques in the implementation of river valley projects. For the introduction of these techniques, it would be necessary to have properly qualified staff in the organisation for proper functioning. Moreover, persons at all levels of management will have to be fully conversant with these techniques. The Committee, therefore, recommends that adequate arrangement may be made for the training of project personnel for this purpose.

199. One important reason for delays in construction and consequent increase in cost is absence of detailed planning as regards personnel, construction plants, stores and materials, planning anciliary facilities required for construction, etc. The Committee feels that adequate attention has not been given to this aspect. In most cases, at the time of preparation of the project report, not much attention is paid to preparation of realistic construction schedules for the project. Mostly the programme is drawn up giving a sketchy bar chart without giving detailed considerations to the various factors which affect the programme like physical possibility of attaining the targets, collection of basic raw materials, time required for acquisition of land, procurement of construction equipment, etc. The sequence of operation and vital activities that affect the progress are often missed. Due to lack of detailed programming bottlenecks are not visualised in advance. It is the Committee's view that the degree of detailed programming in early stages of a project, is generally inadequate for proper planning and subsequent control.

200. For the success of any venture, it is imperative that a detailed plan of work is chalked out and schedules drawn up visualising each important activity and taking into account the limitations and inter-relationship of one group of activities with another. For this purpose, the Committee recommends the use of modern programming techniques such as Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM), whereby all the tasks necessary for attainment of the programme are properly spelt out. These techniques constitute an integrated schedule which ties together all activities and milestone target dates, distinguishing the critical and non-critical operations. Such programmes give a more realiable assessment as regards the period required for the execution of a project. The use of networks provides a realistic basis for technical monitoring and represent a superior technique to bar charts, where the individual tasks defined are too large and milestones far too apart to allow prompt detection of actual and potential deviations from the programme. PERT/CPM networks may be attempted right from the project formulation stage so that the programmes so drawn up can form part of the project report.

## Materials Management & Inventory Control

201. Some of the large projects being executed or likely to come up in future have inventories running into thousands of items, more so because of the high degree of mechanisation of construction operations. Projects requiring the use of heavy earthmoving machinery particularly require huge number of spare parts to be stored for efficient running of machines. Moreover, projects like Beas & Ramganga which are being executed through departmental agencies need colossal amount of stores of various kinds for the procurement of which large investments have to be made. The Committee, therefore, feels that it is necessary in case of major projects to adopt the modern systems and techniques of Material Management and Inventory Control, the use of which is a sine qua non to achieving optimum inventory levels and thus reducing the expense the maintaining surplus stocks while at the same time minimising the risk and frequency of costly stockouts. This would lead to

greater operational efficiency, optimum utilisation of materials and savings in costs.

## Cost Control

202. It has been noticed that in a number of cases the revised estimates have not been drawn up by the project authorities in a proper manner and in the same lines as the original estimate. They also very much lacked the supporting details. As a result it has not been possible to co-relate and compare and provisions made in the two estimates as also assess the reasonableness of the provisions made. While technical sanctions have been given by the concerned authorities for all the detailed estimates, these have not been compiled in time to bring up the original estimate correctly and properly.

203. From the inadequate provisions seen in the project estimates even at the revised stages, it would appear that there are no watchdogs worth the name in the projects who would keep track of the rise in costs and the missing provisions.

204. The Committee feels that there is great need for creating an awareness of the fact that efficiency and output can be improved and the cost cut down by keeping a proper record of running costs and maintaining a system of regularly analysing and reporting them.

205. All this can be done by a properly set up Cost Engineering Cell in the project. It is found that the Ministry of Irrigation and Power have already advised the State Governments in this connection vide letter No. 7(1)/66-Policy, dated 30.8.1969. In this, the duties and functions of cost cells including their staffing pattern have been indicated. A copy of the above letter is given in Appendix 8. To strengthen the team a qualified Cost Accountant may also be included in it.

206. The Committee wishes to emphasise the importance of establishing such cost cells on major projects, which will go a long way in controlling the costs and in keeping the estimates up-to-date.

## Management Information System

207. The modern management techniques cannot be adopted in isolation. These have to be integrated in a comprehensive Management Information System for use in monitoring the construction of a project. Basically, such a system is designed to provide the required information at the right time in

the right form. It is meant to obtain, abstract, store and analyse Data to provide Information for use in the decision-making control. The Committee recommends that a Management Information System designed to provide information on cost and time for use by the project managers for decision-making be devised. A major portion of the information and reporting system may be based on the use of net-work techniques for controlling the scheduled progress of work at the project level.

## Performance Budgeting

208. For effecting proper budgetory control, the system of 'Performance Budgeting' has been evolved in the recent years. This is essentially a process whereby the activities of the various units responsible for the execution of a project are transcribed into organisational work and financial responsibilities. It focusses attention on performance targets while giving indication about the money to be spent. It thus enables the administration or a top executive to have a correct appreciation of the physical progress of work along with its financial progress and thus represents a superior technique than merely gauging the progress in terms of expenditure incurred - a practice followed hitherto, which did not serve to give any indication of actual performance achieved in programme execution. Recognising this system as a valuable tool for intelligent financial management of projects, the Government of India, on the recommendation of the Administrative Reforms Commission have introduced 'Performance Budgeting' in most of the Ministries. A suitable reporting system has also been devised so that the performance budget could be used as an effective tool of management.

209. The Committee recommends the adoption of 'Performance Budgeting' system for execution of river valley projects for exercising effective financial control. This system requires precise formulation of programmes of various units in a project laying down performance yardsticks, measurement of works involved and a recording system for registering variations between budgeted and actual costs. An efficient performance information and reporting system necessary for the success of this technique is ensured because of the adoption of various modern management techniques, which the Committee has advocated in the foregoing paragraphs.

## Planning for construction plant & equipment

210. More and more projects, because of their complex nature and size, are being executed with a very high degree of mechanisation in the construction operations. Jobs involving construction of dams of various types generally require very sophisticated concreting plants & auxiliary equipment for the manufacture, transport and placement of concrete, very large fleets of heavy earthmoving equipment and other machines needed in this type of heavy

construction. The selection of construction equipment and choice of construction procedures is a specialist's job, which requires a thorough insight into various problems faced in construction and an expert knowledge about the performance of the different types of equipment to suit a particular purpose. Wrong methods of construction and improper selection of equipment lead to delays and increase in construction costs. At present, barring a few projects, not much consideration is given to this aspect. Planning for construction equipment at the project formulation stage is almost totally absent. The Committee is of the view that this aspect should be given due importance right from the stage of formulation and the project report should contain a complete blue-print of construction procedures and types of equipment proposed to be used in the execution of the project. Visualising the appropriate construction procedures would also help in framing correct item rates and consequently realistic estimates. The Committee further recommends that steps should be taken by the State Governments for pooling the expertise available with them and creating a cell which would advise and help the project formulation agencies in the preparation of construction schemes, equipment selection and plant layouts.

## Agency for execution of works

211. The Committee has come across the case of delay in execution of project at Jayakwadi due to the fact that the contractor for part of the masonry dam work afailed to deliver the goods and the work had ultimately to be withdrawn and executed departmentally and in the process much time was lost. Similarly, at Ramganga, the contractor for tunnel failed to complete the job within time, delaying the completion of the entire project by two years. A number of works in the Koyna-Stage III Project had to be withdrawn because of the failure of contractors to come up with the performance. These instances underline the importance of finding the right type of agency for the execution of such major works as have to be done in the river valley projects.

212. There is a dearth of good contractors in the country. The number of big construction firms with resources and expertise to execute jobs of large dimensions and with high degree of complexity can be counted on finger tips. In some specialised fields of construction like tunnelling, the choice is extremely limited. From the high rates quoted by these firms for some recent jobs it is feared that a monopolistic situation is taking shape. If this state of affairs is allowed to continue, construction costs are bound to go up beyond all reasonable limits.

213. On the other hand, entrusting works to small contractors has other drawbacks. Because of their limited capital, such firms are not capable of executing big jobs and particularly where high standards of specifications are required. There are instances when such firms were awarded works beyond their capacity, they could not deliver the goods.

214. Under the circumstance, what should be the general policy as regards execution agency for the work? Should the works be given out to a contractor or executed departmentally? This question was debated at great length by the Committee and the pros and cons of the alternatives gone into. There are many advantages in the departmental execution. In case of major and complex projects, since engineering investigations are never in a finished stage at the time of drawing-up the original project report, it is always advantageous to execute the works departmentally stage by stage as the investigations are finalised. If the construction is given out to a contractor, the works and programme have to be indicated in a specific manner. Wherever, there is any deviation from the original programme, additional expenditure has to be incurred, whose nature is always uncertain. A contractor can take advantage of such a flexible programme and demand amounts which are highly unrealistic. In the middle of the work it is not possible to change him and, as such, in most cases, Government has to submit to his inordinate demands.

215. There are no doubt certain advantages in employing a contractor. The contractor can extract work from the labour much more than what governmental agencies can hope to obtain. Government being an ideal employer, it is always subjected to pressure from labour unions of a type different from the one to which the contractor is exposed. At slack seasons, when works are slowed down, it is not possible in a governmental set-up to start retrenchment of idle labour. It is bound to creat commotion. In such a situation pressure will be put from all quarters and Government has to create work when there is really none. All these will add to cost which could be avoided if the agency of execution is altered from Government to that of a private contractor. Again, a private contractor is in a better position and is under no scruples to procure items when they are in short supply from sources which are not particularly ethical. The Governmental agency is unable to do so. It has to practice certain norms and ethics. It has to go by convention and rules laid down in Governmental administrative system. All this causes delay and adds to cost.

216. There are certain disadvantages from which a contractor suffers. A contractor does not command easy financial resources. Particularly in view of the present change in the financial system of the country, it is difficult for the contractor to obtain bank guarantees as well as advances. Formerly when the banks were not nationalised, they had personal contacts with bank officials which enabled them to get advances and bank guarantees easily as and when required. Overall national consideration led the Government to nationalise banks for aggregate welfare of the common man. However, this has created a problem in the field of private finance. Apart from finance, there is the question of procurement of materials such as cement, steel, etc. at reasonable rates. Government has got an advantage in these matters. It can obtain at concessional rates many items which a contractor cannot. Accordingly the contractor would quote higher prices.

217. Having considered in detail all the aspects as discussed above, the Committee came to the conclusion that the policy for execution of an irrigation or multipurpose project should cover the following procedure:-

In general, for big jobs, execution through departmental agencies should be encouraged. This would, in the long run, ensure development of the required expertise on a large scale in the country and help break the monopoly of a few firms in the field.

Projects which are of complex nature and where there is possibility of changes being effected as a result of further investigations during pre-construction stage, should invariably, be executed by departmental agency.

Projects which are fairly well defined can be got executed through contractual agency if suitable contractors come forward.

When work is handed over to a contractor, arrangement could be made to provide him with sources of easy finance, cheaper and quicker supply of materials and other conveniences so that he can execute the work quickly and economically. Such measures would also help remove scarcity of good contractors.

Everything else remaining same, when the project is labour-intensive, it would be better to get it executed through the contractor, while a project which is capital (machinery) intensive could be carried out departmentally.

## Procurement of construction materials

218. The Committee has already stressed on the importance of material management in large projects. The country is passing through a phase of shortages. Cement is not available in time because of pressure on wagons, steel for shortage in production, and spare parts for long 'waiting lines' in the foreign exchange counter. Where is the remedy then? A chief engineer of a very important project complained that he functioned more as a chief procurement officer rather than as a chief engineer there. The Committee feels that it would be economical if some reasonable stock-piling of construction material and spare parts is permitted in advance. The Ukai project authorities intimated that they would have suffered more had they not made suitably advance stock-piling of steel and spare parts. Advance programmes of stock-piling should be done very carefully by engineers with experience and foresight and on the analogy of similar projects elsewhere, since the exact requirement would not be known until detailed engineering investigations take place. It has to be kept in view that although the programmes should be made much in advance, the actual stock piling need not be so as it would amount to blocking of money and material which could have been profitably used by others.

219. Wherever it is possible, a cement factory situated near a project requiring a very large quantity of cement for its construction could be linked to the project. More precisely, the production of this factory should first meet the entire requirement of cement of the project including the peak requirement during its construction. This would ensure quicker and surer means of supply, as the project would not have to face uncertainties regarding allocation of sources of supply and consequent lack of co-ordination in the supply of wagons, etc.

# 15. INTEGRATION OF ANALYSES

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220. The mounting costs and the frequent revisions of project estimates and consequent delay in the implementation of the water resources projects and accrual of benefits therefrom have been causing great concern to the Government. There has been no scientific investigation so far into the causes leading to the large number of revisions in the project estimates. The Government of India, therefore, decided to refer this question to a committee of experts so that a sound policy could be framed for the formulation and implementation of the future irrigation and multi-purpose projects. Under the terms of reference, the Committee has been asked to examine specific aspects of investigation, formulation and execution of the projects and recommend improvements of the present procedure.

221. How the Committee went about its work, what was the methodology adopted for its enquiries, what were the limitations faced by it, what was the outcome of detailed case studies made and what are the Committee's findings and suggestions on the various issues have all been explained in detail in the foreging chapters. In this chapter endeavour has been made to integrate what has been discussed earlier and the conclusions drawn by the Committee. The problem presented before the Committee in the context of the time at its disposal was a great challenge. If the task had to be handled in a scientific manner it must follow the appropriate methodology. With a group of experts stationed in the remote parts of the country busy in their own routine and with a secretariat consisting of persons who too have their normal round of duties with no additional assistance, the progress could not be as fast as one would like it to be.

222. In order to adopt a manageable course of action the Committee on the one hand prepared a questionnaire on the formulation, planning and execution of projects and issued it to selected project authorities to elicit information and opinion about the projects under their control. On the other hand, detailed and penetrating analysis of six projects selected for the purpose was done for identifying and quantifying the reasons for increase(see Appendix 4).

223. Small projects do not produce problems whose impact on aggregate planning is of a very significant character. Their cost implications on the economy are of a small order. A realistic course of action accordingly was to focus attention on major projects. Such projects were roughly 90 in number. Many of them have already been completed. Out of 220 continuing projects, 64 were singled

out as major projects. A project which involves an expenditure of Rs. 500 lakhs or over is called a major project. Appendix 2: Cost escalation of major irrigation and multipurpose projects gives the names of these projects by States, their dates of sanction, first estimates and revised estimates in crores of rupees and percentage rise of the revised estimate over the first estimate. The Committee thought it best to draw a representative small sample from these 64 projects after statistically analysing them in two types of stratum viz., stratification by revised cost estimate and stratification by cost escalation. A sample of six projects was drawn, three from the large (viz. Ukai, Beas Unit I and Ramganga), one from the medium (viz. Jayakwadi Stage I) and two from the small cost group (viz. Kallada and Kangsabati). Large projects for this purpose have been taken as those whose cost estimate exceeds a sum Rs. 100 crores, medium projects whose cost lie between Rs. 51 crores and Rs. 100 crores, and those of Rs. 50 crores and below have come under the small group. Incidentally, they also cover two projects from the high cost escalation group i.e. where the escalation is 100% or more (viz. Ramganga and Kallada) and the other four from the medium cost escalation group i.e. where the escalation is between 50 to 99%. These six projects were taken up for detailed study.

224. The Members of the Committee visited Ramganga, Ukai and Beas-Sutlej Link Projects and discussed at length the various problems which the project officers experienced in executing their work. In short, through penetrating cost analysis, economic and statistical studies, detailed discussions with officers who had gained their knowledge by working in different parts of the country, across the desk discussions with officers who had actually executed projects in Gujarat, U.P. and the Punjab, the Committee drew its basic material which was later put to scientific scrutiny for arriving at the conclusions.

225. There is a general expectation that the estimated costs of works concerning irrigation and multipurpose projects should be as good as those of buildings and roads or industrial projects. The fact is lost sight of that unlike these projects, a river valley project is more complex and its planning involves multi disciplinary activities to a much larger extent. Starting from such immeasurable forces as public pressure to semi-measurable and measurable factors such as economic demands, agronomic, geologic, meteorologic, topographic, hydrologic, engineering and management, all bear upon the preparation of irrigation and power projects. Such a project involves colossal amount of investigations all of which cannot be completed at the stage of submitting a feasibility report. For these highly complex projects it is not very much possible to frame perfect estimates in the first instance. However, it is always possible by virtue of adequate investigations to restrict such increases within reasonable limits.

226. Economical and timely completion of irrigation and multipurpose projects depends, amongst other things, on availability of key materials like cement, steel, coal, equipment and spare parts, as also on transport facilities. Any failure in the timely supply of these items has an immediate adverse effect on the construction schedule. It is well known that supplies of all these items are subject to great shortages. It would, however, be improper to hurriedly apportion blame

to those responsible for their production. They have their problems and they are striving hard to solve them. Nevertheless it is important to recognise them as factors affecting cost and contributing to delay over which no technical or administrative control is possible.

227. A number of unknown political and enonomic variables like nationalisation of banks, introduction of welfare measures, etc. enter into the picture during the gestation period of the project. This is but natural in a democracy being built on the principle of fast social changes. Every change of this nature brings along with it certain bottlenecks which impinge upon the pre-scheduled programme of activities. Assumptions are proved false, scarcity appears unexpectedly, management problems suddenly become insurmountable, costs rise and the whole machinery of planning is put out of gear. Once again, this may be only a passing phase but from the point of view of analysis and the task presented before the Committee this factor had to be kept in view.

228. The estimate of a river valley project is made at a point of time and the project is executed over a period of time. Other things remaining same, the comparison of estimates at two points of time is valid only on the assumption of constant price. This obvious fact is often forgotten, at least mixed up at par with other causes of escalation. In analysing the project estimates selected for the purpose, the revised estimated costs were scaled down to price levels prevailing at the time of preparation of the original estimates in order to get a true picture about cost increases on various counts. Attention was focussed to identify the principal causes of increase in the costs of projects and delay in their execution viz., rise in prices; inadequate investigation; inadequate provisions; change in scope; changes in design & additional requirements; and other causes like increase in land rates, rehabilitation measures, paucity of funds & poor performance of equipment. The data presented in the project reports and more so in the revised estimates defied appropriate statistical analysis. Causes could not always be identified in quantitative terms. Statistical analysis in all situations, particularly in those where data are not properly defined and adequately measured do not always lead to valid results. They must be supplemented with the intelligent appeal to experience. Subjective analysis and opinions of experts cannot absolutely be ruled out as unscientific. A blending of the two methodologies seemed appropriate to the subject under investigation. The idea was to adopt a realistic and manageable course of action.

229. Execution of projects is very often subject to administrative bottlenecks, inadequate planning for men and material, poor management at technical levels, failure of contractual agencies, labour troubles, etc. The end result here is also the same i.e. construction is delayed and costs mount. Despite pointed questions asked in the questionnaire to selected projects to indicate separately the actual delays that have occurred in the project execution due to non-availability of equipment and spares, difficulty in procuring the construction materials like cement and steel, delay in decision making, inadequate availability of funds, etc., they were unable to pinpoint the delays attributable to each cause quantitatively. Investigations,

estimating, preparation of comprehensive schemes, designs, budgeting,.etc. all contain in them the element of management and if they have caused the increase, the lapses in management can have a share in them but it defied quantification. Except for this, the analysis made provided a fairly correct insight into the structure of the cost escalation bringing out the relative magnitude of the various contributing factors. It helped to think about the remedies considering the importance of each factor in the total escalation structure.

230. In the terms of reference the Committee has been assigned with the following responsibilities.

To examine

(a) the adequacy or otherwise of the existing arrangements for the investigation and formulation of irrigation and multipurpose projects, preparation of feasibility reports and estimates thereof and construction programme including assessment of benefits;

(b) the reasons for rise in the estimated costs of projects leading to their frequent revision; and recommend

(c) modification or revision in procedures for more realistic preparation of project feasibility reports and estimates as also improvement in the present system of implementation of projects to ensure their completion within the sanctioned estimated costs and according to the scheduled programmes of completion.

231. As a result of critical survey of the existing type of machinery for planning of irrigation and multipurpose projects and the deficiencies observed at the time of actual execution which had to be rectified, the Committee came to the conclusion that the present arrangements leave much to be desired. The detailed case studies of projects revealed that a major chunk of cost escalation could be identified as attributable to inadequate investigations at the initial stage. This ranged from about 8% to as high as 33%. Barring a few projects in the centrally administered territories, a few States like Jammu & Kashmir where the investigations are carried out generally under the aegis of the Central Water & Power Commission, investigations for most of the projects are done by the State Governments. In general the job is entrusted to a separate Sub-division or a Division under an Existing Division and Circle functioning under the overall supervision of a Chief Engineer. Most of the senior and experienced officers are pre-occupied with other work and routine matters and cannot devote themselves in depth to this work of investigations. The persons at junior levels who actually work in the field are the raw hands. Proper attention is not paid to this wing of the organisation and no effort is made to post experienced and bright persons having requisite capabilities who can do justice to this demanding assignment which requires best of technical judgement and intimate knowledge of planning and construction procedures. The investigations of water resources projects involves many disciplines like engineering, geology, hydrology, etc. There is no

appreciation of the role that specialists in these subjects may play in drawing up of the scheme properly. It is also found that there is no procedure laid down to guide what would be the minimum investigations necessary for a proper formulation of a project.

232. Even where the Chief Engineer in charge of irrigation and multipurpose projects wishes to carry out the investigations in a more thorough manner, he finds himself stuck up with paucity of funds. Not enough funds are made available for investigation work. To cap them all there is always a rush for quickly preparing a feasibility report for transmitting it to the decision making authority. Neither sufficient time nor adequate personnel are made available for doing a good and accurate job on the preparation of a feasibility report. It is noticed that while investigations are still done for dams and barrages, much less attention is paid in this respect to the distribution system. It is, therefore, no surprise that the estimates turn out to be grossly understated.

233. The Committee has enquired about the data base for the project reports. The importance of adequate basic data for drawing up development projects at minimum cost cannot be over emphasized. The Committee feels that there is much room for improvement as regards collection of various types of data essential for proper formulation of a project. To quote an example, there are various deficiencies as regards collection of rainfall data like absence of full-time observers, faulty maintenance of rain-gauges, lack of trained statisticians for supervising the work. There are not enough stations for recording stream-flow data. At present not much attention is paid by the engineers responsible for the formulation of projects to the source and quality of data available on hydrology and various other disciplines. This 'blind' acceptance of data can lead to faulty plans, whereby objectives sought may not be achieved and costs may go up. Use of inaccurate data could lead to serious errors is estimation of water availability, magnitude of floods, design of engineering structures and inaccurate conception of the project as a whole vis-a-vis benefits and costs. There is thus need to ensure by various checks the quality of data before they can be classified 'dependable' for use in water resources planning. This requirement can be met only by having a suitable agency to co-ordinate the work of data collection, under supervision of professionally qualified statisticians at appropriate levels.

234. The project proposals formulated by the States are subjected to scrutiny by various agencies in the Government of India, chiefly by the Central Water and Power Commission (CW&PC). CW&PC has a fairly good organisation for the technical scrutiny of all aspects of the projects received by it. This no doubt helps in rectification of many deficiencies relating to design, planning & estimates contained in the original proposal submitted by the States. Notwithstanding this scrutiny, the project costs have soared high with frequent revision of cost estimates. C.W. & P.C. is unable to control this primarily because it has no control over the basic data on which the proposals are made and for the collection and supply of which the State agencies are responsible.

235. The scrutiny of project reports at the Centre is sometimes delayed for many reasons like lack of vital data in the reports, further investigations by States, revision of reports and their re-examination, further correspondence for incomplete replies from States, co-ordination of comments in C.W.& P.C. received from a large number of agencies, want of agreement on inter-State aspects, etc. The States have been requested to obtain prior clearance of the schemes from their Finance, Revenue and Agriculture departments and settle inter-State issues. The set up for technical examination of projects in C.W.& P.C. also needs to be streamlined and suitably strengthened. It has also to be seen if examination of the same aspect in the project report by two departments can be dispensed with to avoid delay.

236. For investigation of projects in general, each State should have a broad-based organisation involving all disciplines (engineering, geology, hydrology, revenue, agriculture, etc.) so that the work is done by persons experienced and expert in each of the specialised fields.

237. Adequate monetary incentives as well as other compensatory benefits should be provided in order to attract bright and enthusiastic officers to come forward and undertake field investigation assignments under arduous conditions of life.

238. Suitable funds should be allocated for investigating properly the projects proposed. A part of this allocation could be on earmarked basis for investigation of specific important and complex projects.

239. Very big projects costing over Rs. 30 crores would require a more strict treatment. In their case the first stage should invariably be the sanction of an investigation estimate on the basis of the preliminary project report. The detailed project report should be sanctioned after the proposals have been thoroughly investigated.

240. For improving the availability and quality of basic data needed for water resources projects, the Committee recommends that a Standing Committee should be set up for development of basic data. It should be entrusted with the work of drawing up annual plans for data collection and analysis and co-ordinate with appropriate governmental agencies engaged in the development of data. The Committee further recommends the establishment of national and regional water data banks for storage, retrieval and analysis of data collected by various agencies. It has further been outlined in detail in Chapter 5: Data Base for project Reports, the tasks in specific fields, which should be carried out to improve the data status.

241. The Committee found that the Central Water & Power Commission has recently laid down the minimum investigations to be carried out before preparation of a project report and estimate for approval of the Planning Commission which it circulated to all the State Governments during February/March, 1972 vide Appendix 7 of this report. The Committee strongly advocates that a more active role should be played by CW&PC in this field. It should associate itself more closely with the investigation agencies of various States and give them necessary guidance and assistance in their work. The Commission should monitor closely the investigation work on major and complex projects and ensure a thorough work in the quickest possible time so that there is no large time interval between the approval of a scheme for investigation and its approval for actual execution.

242. The Committee is aware that even after the minimum investigations have been done there may be surprises in stock in underground works like foundations of dams and boring of tunnels and it is only when these are opened that a more perfect estimate may be formed.

243. A glance at the table given in Appendix 2: Cost Escalation of Major Irrigation and Multipurpose Projects will show that large irrigation projects about whose cost escalation the Committee was particularly concerned were mostly started after 1961. A review of the general economic situation of the country during the decade that followed may be interesting in this connection. Appendix 5: Statistical Indicators gives a list of price series which may help to review in broad terms the stress and strain through which the country passed during the crucial period under discussion.

244. It has been explained that the planning and execution of water resources projects cannot be viewed in isolation from the other sectors of developmental activities in the country. Planning of these projects will be thrown out of gear if there are failures on the part of those who are responsible for items like equipments, construction material, and transport facilities. It has also been brought out that other sectors are striving hard to improve. This provides hope for the future but not certainties. In view of the revolutionary social and economic changes through which the country is passing it may be difficult to hold the price line. It has been brought out that our economic well-being also depends on monsoon which is an unpredictable factor. Inflation also depends on that, everything else remaining same. Again, as long as population is growing at the present rate and commodity production is not growing at the rate desired, prices are bound to grow. Inspite of all this no provisions are made in an estimate to have a cushion for such a changing phenomenon in the economic scene.

245. Since rise in prices has been very much marked during the last decade, the increase in costs of projects on this account is very significant.

There can, therefore, be no basis for the expectation that the projects should be executed within the sanctioned estimated costs. From the detailed examination of project estimates the increase due to price escalation has been found to range from 35% to 120% of the original estimate. The Committee felt that although it will not be desirable to have any radical change in the existing administrative procedure to prepare plan estimates at current prices, as an instrument of planning it would be unrealistic if no arrangements are made to take notice of the crucial factor of inflation. For this purpose a suitable cushion should be devised which may fit in with the governmental financial mechanism. Approval of a scheme takes some time. Commencement of real construction work after approval also takes time. Then comes the construction period. The Committee recommends that to cover the increase owing to economic changes over the long period, an appropriate indicator of price rise may be constructed and the increase so obtained added to the estimate as a 'supplementary provision' for adjusting the cost estimates of plan projects. Such provisions will create a sense of awareness in those who are responsible for making financial arrangements. It will also fix responsibilities for different components of price rise in a realistic manner.

246. The Committee made very detailed studies about the rise in prices of the various commodities that go into the project costs, the upward trend of the rates of major items of works after analysing construction cost indices made for them, and the impact of inflation over the years on the costs of projects examined and concluded that a factor of 7% per year would be a reasonable one for adjustment of the estimated costs. The Committee, therefore, recommends that an Adjustment Factor of 7% per year should be adopted for working out 'supplementary provision' for adjusting the cost estimates of planned projects. In applying this factor the estimated cost of the project should be relieved of the cost of land and only 50% of this factor should be considered for the period of actual construction.

247. The Committee further recommends that the adjustment factor should be reviewed from time to time after taking into consideration all aspects of the economic situation in the country. For this purpose the Central Water & Power Commission should have a study cell for collection of data and preparation of Construction Cost Index for the works of river valley projects.

248. From the detailed analysis of the project estimates it has been found that quite a big segment of the total increase in the cost of a project is due to the fact that the original provisions made in the estimate at the time of approval of the scheme were inadequate. The increase on account of inadequate provisions ranged from about 8% to 22%. The inadequacies in the estimates result from lack of experience, failure in visualising the construction methods and procedures in advance, making provisions for major lumpsum items without any attempt to work out the cost even on a

rough basis, improper estimation of requirement for establishment, buildings, facilities, etc. In some cases inadequacies result from failure to allow sufficient time for framing of proper estimates. Sometimes a deliberately over-optimistic attitude in estimation can be traced to pressures from various quarters. The reason behind all such attitudes is the anxiety to get the projects through but they prove very harmful as they lead to the failure in proper sectoral planning. The enhanced requirements of funds cannot be immediately met and completions of projects are delayed.

249. Inadequate provisions are quite huge in the giant multipurpose projects of Ramganga, Ukai and Beas-Sutlej Link which range from 18 to 22%. The estimates of these projects were prepared between 1949 to 1961. The Committee noted that the experience at the early stage of formulation and construction of such major projects in a fully mechanised process was not very wide nor was the Himalayan region much known. The Committee also note that in the present system of strict checking of rates and provisions done in CW&PC, huge inadequacies of this nature would not occur provided the basic information and data furnished in the report are correct.

250. The attitude of making inadequate provisions in the estimates entails a greater responsibility on the part of those who are concerned with the scrutiny and approval of these schemes. They have to identify the deficiencies and rectify the inadequacies in the estimates. The Committee feels that there is a case for exercising more care in framing the estimates by those concerned with their preparation, as also those who check them. Advantage may be taken of the finalised cost figures incorporated in the completion reports of already executed projects. In this context the Committee strongly recommends that the preparation of completion reports, which has not been given adequate importance in the past, should be insisted upon to be finalised within two to three years of commissioning the project.

251. The Committee found quite a few instances when, because of various factors technical as well as economic the scopes of projects were increased considerably subsequent to formulation of the first reports, whereby the benefits originally contemplated like area to be irrigated, power to be generated, area to be afforded flood protection, etc. were increased. The increase in benefits was naturally accompanied by increase in the costs of projects. While in some, the rise was not very significant, in some others this was very appreciable and ranged from about Rs. 3 to Rs. 11 crores covering about 6 to 16% of the total increase in a project. This gave a very erroneous picture of cost escalation when the cost estimates prepared at two points of time were compared.

252. The Committee is of the view that there may not be any objection in principle to the change in scope provided the incremental cost is justified vis-a-vis the next best available alternative. There is, however, serious

repurcussion of this change. Because of the increased scope, the cost goes up and the entire planning of resources is thrown out of gear. Whether to agree to the changes in scope has to be decided taking into account the economic constraints-availability of funds and resources in the context of overall planning. The Committee, therefore, feels that on this consideration changes in scope may be avoided and projects should be more comprehensively planned at the early stage by placing in charge of investigation and project formulation experienced and competent technical personnel. Such changes in scope may be allowed in situations where, by not making changes in the project features, the chances of effecting increase in scope are permanently jeopardised. In case such changes have to be accommodated after the approval of the project, the additional works should, wherever possible, be sanctioned as separate schemes whose costs have only to be arithmatically added to the earlier project to find out the total cost. This would guard against avoidable criticism of excessive expenditure for the project. When it is not possible to bring up a separate scheme for the change in scope, the estimate of the project with the increased scope should be sanctioned as a "modified project" and not merely as a revised estimate.

253. Because of the complex nature of river valley projects, all the items and requirements cannot be visualised at the stage of preparation of the feasibility report[1] however adequate the investigations may have been. Feasibility reports are based on broad designs for major features. Some changes take place at the detailed design stage which follows vigorous and detailed design studies. These may come due to adoption of changed design criteria, modification of lay-outs, going for a better specification of works and so on. One has, therefore, to reckon always with some increase in cost on account of these changes.

254. In case of headworks i.e. structures like dams, spillways, barrages, etc., even when adequate investigations have been done, some problems not anticipated often arise after opening of foundations which call for lowering of foundation level or special treatment of the foundation or other changes in design and specifications of the structure.

255. In the distribution system structures required for hundreds of miles of canals cannot be designed and estimated fully at the initial stage. The provision for such structures is generally based on parametric estimates making use of cost graphs worked out from statistical analysis of past projects. It is also done on the basis of typical estimates of representative structures. It is only obvious that at the detailed estimation stage of each and every structure there would be variations in costs.

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[1] Project report submitted for approval of the Technical Advisory Committee of the Planning Commission.

256. Investigations for tunnels and other underground works are based on regional geology; a few bore holes drilled along tunnel alignment cannot altogether obviate the possibility of surprises in actual construction. This is more so in case of long tunnels and tunnels located deep under the strata where it is extremely difficult to drill very deep holes over 1000 ft. Methods of tunnelling have sometimes to be drastically changed to tailor them to the requirement of strata encountered during boring. The unknowns and hence the risks involved are far more than works in an open pit. Engineers have to find solution to various problems as they are met with during the construction like tackling highly water charged strata, boring through geologically adverse tunnelling zones, etc. All these cannot be visualised and estimated accurately in terms of cost at the original stage.

257. Power house structures, when built overground have the same problems as the headworks. When underground, they suffer from the same drawbacks as the tunnel. Apart from these, there are numerous small items which are properly estimated only at the detailed design stage like water & sanitary pipes, air conditioning system, metal works, finishing of floors, architectural treatment, etc. Power House structures have often to bear substantial cost increase on this account.

258. To cover all this cost increase which would invariably occur in such projects, an additional provision should be made in the estimate under a head which may be called "Margin of error".

The Committee observed that the increases and reductions on account of change in designs recorded from the examination of selected project estimates were not very consistant and, as such, did not help in arriving at the "Margin of error" which the Committee wishes to recommend.

Members of the Committee on the basis of their experience and after detailed discussions with the engineers of projects visited who have rich experience of their lifetime on the construction of projects recommend the "Margin of error" indicated below for various types of works. This recommendation is made on the premise that the preliminary designs are based on adequate investigations done at the initial stage.

| | |
|---|---|
| Headworks | 10 to 15 % |
| Tunnels & other underground works (In Himalayan region) | 30 to 40 % |
| Distribution System | |
| i) Primary System (consisting of main canals and branches) | 10 to 15 % |

| | |
|---|---|
| (ii) Secondary System (consisting of distributaries and minors) | 20 to 25 % |
| (iii) Tertiary System (consisting of minors & water courses) | 25 to 30 % |
| Hydro-electric Installations (Civil Works) | 40 to 50 % |
| Drainage Works | 20 to 40 % |

259. Apart from the principal causes of cost rise viz. inadequate investigation, inflation, inadequate provision, change in scope, and change in designs & specifications mentioned above, there are others which are instrumental to the escalation of costs of the projects. The Committee found four of this kind to be important which had repurcussions on the costs of projects and the scheduled programmes of construction. These are higher award in land rates, adoption of better standards for rehabilitation, paucity of funds, and poor performance of equipment & procurement problems.

## Higher award in land prices

260 The phenomenal increase in land prices is throwing out the estimates and has become a very troublesome trend vitiating economic construction of irrigation and multipurpose projects. In Jayakwadi project in Maharashtra over 22% of the total increase in cost of the project was found to be due to this factor alone. At the time of preparation of the original estimate, land prices, as per usual practice, are adopted mostly in consultation with the Revenue authorities. These estimate rates are based on current transactions. The Committee has noticed that the rates actually settled by awards have gone up very high. In the six selected project estimates examined, the increase of land rates over the rates adopted in the original estimates ranged from about 81 to 330 %. The Committee also came across instances where execution of projects was delayed due to delay in land acquisition.

261. The Committee within the short time at its disposal could not examine any details concerning land deals and awards with a view to ascertaining reasons for the high rates. It, therefore, recommends that a Central Committee consisting of concerned officials may be formed and assigned the task of evolving a standard approach for adopting the rate of compensation for land which would recognise (i) a fair deal to those affected and (ii) prevent any artificial increase in the cost of land. This has particular relevance to projects whose benefits go to one State while land is to be acquired for areas going under submergence in a neighbouring State. As regards delay in the acquisition of land a number of measures have been recommended by the Land Acquisition Review Committee set up by the

Government of India which the Committee also endorses. These have been indicated in para 171 of Chapter 13.

## Adoption of better standards for rehabilitation

262. The construction of reservoir projects brings in its wake the displacement of numerous persons from their hearths and homes. In the early stages of planning and construction, the usual practice was to pay these displaced persons the value of their land and property acquired by Government with an additional 15 % as solatium for acquisition of land compulsorily.

263. In course of time the idea developed of rehabilitating the persons thrown out suddenly from their homes and livelihoods. This, it is presumed, has been found necessary because of two reasons. First, the compensation paid gradually proved inadequate to purchase the same quantum of land and property and secondly the village folk not being accustomed to handle any big money, lost in no time the cash compensation paid to them and were ruined.

264. The Committee found that the per capita provision on rehabilitation is different in different States. Efforts were made to collect information independently from the various State and projects about the rehabilitation measures adopted and the amenities provided to the persons displaced on account of acquisition of their land and property for the construction of river valley projects. Appendix 9: Measures for rehabilitation adopted in different States and projects would indicate that there is no uniform policy laid down regarding the scale of rehabilitation measures. Standards followed in each State are different. The issues got complicated when a project is located in two States and the question of compensation to be given to the people of one State by the other State on this account crops up.

265. The Committee recommends that a broad national policy on rehabilitation should be laid down with provisions for reasonable modifications being permissible on the merits of each case.

Irrigation and multipurpose projects are economic and quasi-commercial ventures. As such, any additional expenditure incurred towards creating a better environment for the displaced persons is purely on social and welfare considerations and is not a proper charge to construction. The Committee, therefore, recommends that although there may not be any alternative but to charge this to the project cost, it may be excluded for benefit-cost analysis.

## Paucity of funds

266. The Committee noticed during the course of examination of the reasons for rise in cost and delay in the construction of projects that paucity of funds held up progress on certain projects. This resulted in prolonging the construction period and consequently increasing the cost due to inflation and delaying the realisation of benefits. The analysis of the selected projects showed that as against the original completion periods of 5 to 10 years the revised targets covered 12 to 20 years. Although more often than not the periods of completion indicated in the original reports were too optimistic and not related to what was physically achievable, the fact remained that non-availability of adequate funds has had a stranglehold on some of the projects and as a result they could not come up within a reasonable time.

267. What appears to be happening is that the cost of schemes increase and the Government is unable to provide adequate additional funds for the projects. The resources thus get spread too thin. The effect of inadequate financing is that the projects go on languishing and lingering and costs increase enormously because of inflation in prices.

268. The Committee feels that to relieve this situation, firstly the projects should be planned in phases and taken up phase by phase. This will reduce pressure on the financial resources of the country, ensure economic utilisation of the capital and equitable distribution of projects in the country. Secondly, the financial phasing must be made to match the physical phasing. Once a project has been approved by the Planning Commission, funds should be made available fully for its execution. Whether adequate financial resources would be available has to be thought out in advance and planning of resources would have to be done before sanctioning a project. The Committee feels that in allocating financial resources, irrigation and multipurpose projects should receive very high priority and substantial funds so that all projects approved by the Planning Commission are completed in optimal time and further escalations in cost are avoided.

## Poor performance of equipment and procurement problems

269. In course of its enquiries, the Committee heard repeated complaints from the project authorities about the delay in supply of heavy earthmoving equipment and spare parts as also generators and turbines by the indigenous manufacturers, poor performance of indigenous construction equipment, indifferent behaviour of supplier firms, and unsatisfactory procurement policies which seriously hampered the timely execution of the works.

270. It is not possible to get away from the fact that indigenously manufactured earthmoving equipments are not of a very dependable quality

as they are sick too often, their outturn falls short of the schedule which is prepared on the basis of the performance of the imported equipments. The construction gets delayed and the unit costs are pushed up. One has, therefore, to re-assess the outputs of such equipments to make a realistic assessment of their performance. The Committee recommends that suties in this regard may be carried out by the Central Water & Power Commission who should lay down norms in this connection.

271. There is a case for exercising pressure on the manufactures of indigenous equipment which are both in private and public sectors for giving better service to their customers. The Committee suggests that the Ministry of Irrigation & Power may take necessary steps in this regard at the highest level.

272. The Committee was asked to examine the existing arrangements for the framing of construction programmes and to recommend improvement in the present system of implementation of projects to ensure their completion within the estimated costs and according to the scheduled programme of completion. The Committee examined in detail the management factor involved in the execution of river valley projects. It also discussed with the project authorities about bottlenecks created by poor management at technical levels. The examination revealed that there were lacunae and shortcomings in almost every sphere of the project execution which had a great bearing on timely and economical completion of projects. There is pressing need to effect improvements in the various fields of management such as organisation, programming, selection of agencies for execution of works, material and equipment planning, cost control, etc.

273. A basic ingredient as important as all others in implementing an irrigation and multipurpose project is an organisation structured to attain the desired objective. In this connection the Committee endorses the views and recommendations of the Irrigation Commission which inter alia stipulate "that all large inter-State projects and any State project costing Rs.500 million or more should have a Control Board. Even for projects costing less than Rs.500 million but which are of a complicated nature, a Control Board would be desirable. To be effective, Control Boards should be delegated the maximum powers and should in turn be liberal in delegating powers to the Chief Engineers of projects in the interest of efficiency. In States where several projects are under construction a single Control Board with Standing Committees for each project would suffice. This would help to promote the best use of manpower and equipment. Where a major project receives special financial assistance from the Union Government, the Centre should be adequately represented on the Control Board"

274. For a major river valley project there must be a Chief Engineer or a Project Manager posted exclusively for its execution. During its investigations, the Committee noticed that in a major and complex project there were four

changes of the Chief Project Executive in three years time. In a complex multipurpose project it is likely to take six months or even a year for a person to comprehend fully and familiarise himself with the project itself and before he is ready to exercise authority and bring his expertise to bear on the project, he finds himself transferred. This adversely affects the expeditious and efficient execution of projects. The Committee is of the view that there should not be too frequent changes in the key personnel entrusted with execution of the projects.

275. It is not always that a Chief Engineer has the necessary amount of authority to enable him to execute his assignment efficiently. The Committee wishes to emphasise the point that for a programme to succeed it is essential that the person incharge of execution is granted appropriate authority, both administrative and financial so that he may discharge his responsibilities unhesitatingly. The Committee recommends that a team of officials including technical officers from various projects in the country may be set up to go into the question of delegation of powers and draw up a model for adoption in the projects to be taken up in future.

276. At present, hardly any attention is given to prepare a realistic programme of construction at the time of preparation of the feasibility report for the project. Generally, one finds a sketchy bar chart in a project report drawn up without giving any thought as to the practicability in terms of physical, financial or material resources possibilities. Even during execution there is no systematic mechanism in most cases to know about the critical activities and take action in advance. The Committee feels that the remedy lies in going for modern management programming techniques. It recommends the use of Programme Evaluation and Review Technique (PERT)/Critical Path Method (CPM) technique for drawing up realistic construction schedules which take into account the inter-relations of various groups of activities and provide a good basis for technical monitoring. Apart from this measure concerning programming, a complete switch over to modern management techniques is called for to bring about an all round improvement. These cover adoption of modern systems of materials management and inventory control, performance budgeting and a system of management information in execution of major projects. These would lead to greater operational efficiency and optimum utilisation of materials, provide the necessary information for decision making control and better financial management. By adopting "System" approach to the entire question of project management and control, a speedy and economical implementation of projects could be ensured to a large measure. For preparation and operation of programme network and other techniques it would be essential to have qualified staff at various levels of management. For this purpose the Committee recommends that adequate arrangement for the training of personnel should be made in all projects. Further, for a successful implementation of the development programmes, there is a strong need to have competent project managers. In order to create a nucleus of such experts, the Committee recommends that senior technical officers who show an aptitude for project management are earmarked for special training.

A comprehensive institute should be set up in the Centre and preferably in C.W. & P.C. for training in the water resources sector of all officers - engineers, geologists, accountants, planners and managers who are engaged in project works. At the State level also there should be training facilities in the water resources sector for junior officers of the rank of supervisors, junior engineers, etc. The existing facilities like Water Resources Development Centre at Roorkee and Administrative Staff College at Hyderabad should be utilised fully till such time a comprehensive institute at the Centre for training in water resources sector comes up.

277. There should be a constant endeavour to keep the construction costs under control. For this purpose it is necessary that proper cost progress data are collected and analysed all the time and running costs are worked out and maintained properly. This is possible only when there is a system of recording and analysing the cost actually obtaining in the projects and reporting them to the project managers. For this purpose the Committee emphasizes the necessity of establishing Cost Cells on major projects about which the Ministry of Irrigation and Power have already advised the State Governments vide Appendix 8. To strengthen the team a qualified cost accountant may also be included in it.

278. Most of the major projects, because of their complex nature and size are being executed with a very high degree of mechanisation in the construction operations. Jobs involving construction of dams, tunnels, etc. require very sophisticated plant and equipment. The selection of construction equipment and choice of construction procedure is a specialised job which requires a thorough insight into the various problems faced in construction and an expert knowledge about the performance of the different types of equipment to suit a particular purpose. Wrong methods of construction and improper selection of equipment lead to delays and increase in construction cost. At present, barring a few projects, not much consideration is given to this aspect. Planning for construction equipment at the project formulation stage is almost totally absent. The Committee is of the view that this aspect should be given due importance right from the stage of formulation and the project report should contain a complete blueprint of construction procedures and types of equipment proposed to be used in the execution of the project. The Committee further recommends that steps should be taken by the State Governments for pooling the expertise available with them and creating a cell which would advise and help the project formulation agencies in the preparation of construction schemes, equipment selection and plant lay out.

279. Quite a few instances have come to the notice of the Committee where the completion of projects was delayed due to failure on the part of the contractor entrusted with the execution of the works. Construction agencies with resources and expertise to execute complex and large jobs are very few in the country. From the high rates quoted by these firms for some recent jobs it is feared that a monopolistic situation is taking shape. If this state of affairs is allowed to continue, the construction costs are bound

to go up beyond all reasonable limits. On the other hand it is not practicable to take up the construction of works departmentally everywhere. There are advantages and disadvantages both in the departmental execution as well as execution through a contractor.

280. Having considered in detail all these aspects, the Committee came to the conclusion that the policy for execution of an irrigation and multipurpose project should be guided by the following procedure:-

> In general, for big jobs, execution through departmental agencies should be encouraged. This would, in the long run, ensure development of the required expertise on a large scale in the country and help break the monopoly of a few firms in the field.
>
> Projects which are of complex nature and where there is possibility of changes being effected as a result of further investigations during pre-construction stage, should, invariably be executed by departmental agency.
>
> Projects which are fairly well defined can be got executed through contractual agency if suitable contractors come forward.
>
> When work is handed over to a contractor, arrangement could be made to provide him with sources of easy finance, cheaper and quicker supply of materials and other conveniences so that he can execute the work quickly and economically. Such measures would also help remove scarcity of good contractors.
>
> Everything else remaining same, when the project is labour-intensive, it would be better to get it executed through the contractor, while a project which is capital (machinery) intensive could be carried out departmentally.

281. Project engineers were unanimous in putting forward to the Committee one factor as a great bottleneck towards the smooth execution of a project. This was the difficulty experienced by them in procuring cement, steel and spare parts when they are required most. In this connection the Committee suggests that procurement programmes should be made much in advance of the execution and projects having highly mechanised construction programmes should be permitted to stock-pile reasonable amounts of spare parts for the equipments so that hand to mouth conditions are avoided and frequent machinery breakdowns prevented. The Committee also suggests

that wherever possible a cement factory situated near a project requiring a large quantity of cement for its construction could be linked to the project. The production of this factory should first meet the entire requirement of cement of the project including the peak requirement during its construction.

282. A project must pass through a number of feasibility tests before it can be accepted for execution like engineering feasibility, monetary feasibility, political feasibility, social feasibility and economic feasibility.

283. Prior to 1964 the acceptability of a project depended on the rate of return earned by it. Although in 1964 C.W. & P.C. issued instructions to all the State Governments to work out benefit-cost ratios for projects having a return of less than 4.5% per annum (at the end of 10th year after completion), it was only in 1966 that the Government of India, Ministry of Irrigation and Power laid down that, as a general rule, a project should be considered worthwhile only if the B.C. ratio is not less than 1.5. It was further stated that exceptional cases such as those for scarcity and backward areas might, however, continue to receive special consideration.

284. The Committee found that the procedure laid down in the report on Criteria for Appraising the Feasibility of Irrigation Projects published by the Planning Commission in 1965 is generally followed in calculating the B.C. ratios of the irrigation projects. It is, however, observed that there is a big gap between the procedure laid down and that actually followed in working out the benefit-cost ratios. It is understood that in pursuance of the suggestions made in the Criteria Report, a Working Group was constituted by the Planning Commission comprising irrigation experts, economists and planners for preparing a manual of standard procedures and methods for working out the benefit-cost ratio. It is, further, understood that the draft manual so prepared in 1969 is under wide circulation for eliciting comments and suggestions. The Committee suggests that while finalising the manual, the Planning Commission may go into the question of the procedure for assessment of benefits in depth and indicate clearly the data which are required to be collected for the purpose of working out the benefits and costs illustrating at the same time the methodology to be followed step by step in arriving at the benefit-cost ratio. The cost of developing land for irrigation when it newly comes to a region may be appreciable and should not be missed in working out the B.C. Ratio.

It has also been observed that not much attention is paid in collecting proper and up-to-date data for working out the B.C. ratio. The Committee suggests that steps should be taken by the State Governments to make a more thorough arrangement for the collection and maintenance of the data required for this purpose.

285. The Criteria Report says that data regarding irrigated area and intensity of irrigation would be available from the project reports. The reliability of these data will depend on how they have been collected and used. The Committee in course of its examination of the revised project estimates has found that substantial changes have taken place in the revised reports due to inadequate investigation at the early stage. Such changes covered hydrology as well as irrigable area. Moreover, the costs of projects have gone up in the revised estimates disproportionately to the increase in benefits and at least in one case this has upset the economic viability of the project. It is also observed, as already mentioned, that the work of collection, compilation and adoption of data required for working out the B.C. ratios is not in a very good shape. Under the circumstance, the benefit-cost ratios worked out at the feasibility report stage cannot be considered to be very representative. This would improve only when there is all round improvement in the preparation of estimates and collection and utilisation of proper data for the purpose.

286. The benefit-cost criterion for appraisal of irrigation projects is now in vogue for the last about eight years. It is necessary to see how it works out with the projects completed and compares with the one assessed at the formulation stage of the project. With the short time at its disposal, the Committee could not go into such details. It recommends that there should be someone like the area development authority in every State who should be responsible to watch continuously all the developments brought by irrigation so as to maintain an integrated view of the area. The Committee further recommends that in every State socio-economic studies for evaluation of benefits derived from the projects after completion should be taken up and done periodically by suitable agencies in association with the planning departments, universities, etc. This would help in framing future policies to effect further improvements.

# 16. RECOMMENDATIONS

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## Investigation and planning of projects

1. For investigation of projects in general, each State should have a broad-based organisation involving all disciplines (engineering, geology, hydrology, revenue, agriculture, etc.) so that work is done by persons experienced and expert in each of the specialised fields.

(Chapter 9, paragraph 125)

2. Immediate steps may be taken to set up a standing committee for the development of basic data required for planning water resources projects; such a committee must establish liaison with appropriate governmental agencies engaged in the development of data; the committee must prepare annual programmes for data collection and analysis.

(Chapter 5, paragraph 61)

3. A minimum standard for factual information which a project report must meet before it can be considered for acceptance should be established.

(Chapter 5, paragraph 61)

4. Steps should be taken to see that researches are continued to improve techniques of data analysis; programme of in-service training to impart recent technical know-how in this subject must also be developed.

(Chapter 5, paragraph 61)

5. Steps should be taken to improve data status:

Hydrology: More raingauge and evaporation recording stations; scrutiny and analysis of existing data through computor; more surface water gauging stations; temperature recordings at these stations to be increased; more

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|---|---|
| | intensive ground water survey; more observation wells; more samples for analysis of chemical and sanitary quality of water. |
| Sedimentation: | More stations for sampling of sedimentation loads; more survey of reservoirs; scrutiny and analysis of existing data. |
| Topography: | An annual programme of adequate magnitude for topographic mapping must be prepared; topographic mappings of critical areas must be completed first; maps must be updated from time to time. |
| Geology: | The country must be covered by standard geological maps showing surface as well as structural geology for water resources development. Certain time target may be specified for the purpose. |
| Soils: | Nationwise soil classification and mapping must be completed within a certain period depending upon the resources; more coordination of activities between the agricultural and engineering departments; cadastral surveys must be completed as early as possible. |
| Vegetation: | Forest surveys must be completed within a reasonable period. |
| Fish and Wild Life: | Information on population, trends and densities of fish and wild life species must be collected. |
| Socio-economic: | Such data on population, means of livelihood, transportation, trade, industrial production, power and flood damages not regularly collected by existing agencies must be covered; necessary geographic and time break-downs must be obtained; necessary data on agriculture may be obtained through the National Sample Survey Organisation (Cabinet Secretariat); similar data on industry and mining through surveys carried out by the Central Statistical Organisation and the Indian Bureau of Mines; data on recreation should be collected through surveys to be conducted by the Department of tourism; data on domestic and industrial water supply must also be collected through appropriate agencies; data on water pollution must be collected |

through the Department of Health and special surveys; effect of land management on watershed hydrology must also be studied.

(Chapter 5, paragraph 61)

6. Steps should be taken to set up national and regional water data banks for the storage, retrieval and analysis of data collected by various agencies.

(Chapter 5, paragraph 61)

7. Adequate monetary incentives as well as other compensatory benefits should be provided in order to attract bright and enthusiastic officers to come forward and undertake field investigation assignments under arduous conditions of life.

(Chapter 9, paragraph 126)

8. Suitable funds should be allocated for investigating properly the projects proposed A part of this allocation could be on earmarked basis for investigation of specific important and complex projects.

(Chapter 9, paragraph 127)

9. Very big projects costing over Rs. 30 crores require a more strict treatment. In their case the first stage should invariably be the sanction of an Investigation Estimate on the basis of the preliminary project report or reconnaisance report. The outlay on such an estimate could be as much as 5% of the anticipated total cost of the scheme and should be sufficient to enable a well-manned organisation to be set up at the project site for carrying out thorough investigations and preparing detailed estimates in terms of accurate data on quantities, etc. The organisation should be headed by a senior engineer who could be expected to take over the execution of the project also in due course.

(Chapter 9, paragraph 128)

10. The C.W. & P.C. should associate itself closely with the investigation organisations set-up by the States and give them necessary guidance and assistance in their work.

(Chapter 9, paragraph 129)

11. The guidelines laid down by C.W. & P.C. for the minimum investigations to be carried out before preparation of a project report and estimate for approval of the Planning Commission should be strictly followed for preparing the reports and estimates of all major irrigation and multipurpose projects in the country.

(Chapter 9, paragraph 124)

12. C.W. & P.C. should prepare and issue guidelines for investigation of drainage part of the schemes.

(Chapter 12, paragraph 165)

13. Studies regarding outputs of indigenously manufactured earthmoving machinery should be carried out by C.W. & P.C. and norms laid down.

(Chapter 13, paragraph 188)

14. Selection of construction equipment and choice of construction procedures is a specialist's job. Steps should be taken by the State Governments for pooling the expertise available with them and creating a cell which would advise and help the project formulation agencies in the preparation of construction schemes, equipment selection and plant layouts.

(Chapter 14, paragraph 210)

15. State Governments should make a more thorough arrangement for collection and maintenance of the basic data required for working out the benefit-cost ratio viz. cost of inputs like seed, manure, etc.; value of outputs like produce, fodder, etc. and operation and maintenance charges of irrigation projects.

(Chapter 6, paragraph 83)

16. There should be someone like the area development authority in every State who should be responsible to continuously watch all the developments brought by irrigation so as to maintain an integrated view of the area. In every State socio-economic studies for evaluation of benefits derived from the projects after completion should be taken up and done periodically by suitable agencies in association with the planning departments, universities, etc. This would help in framing future policies to effect further improvements.

(Chapter 6, paragraph 85)

17. With a view to reducing pressure on the financial resources of the country and ensuring economic utilisation of the capital and equitable distribution of projects, these should be planned in phase and taken up phase by phase.

(Chapter 13, paragraph 183)

18. To avoid change in scope of a project (such as, increases in area to be irrigated, increase in power generation capacity or increase in flood control benefits) during construction the project should be planned more comprehensively at the early stage.

(Chapter 11, paragraph 152)

19. There is no objection in principle to the change in scope during construction provided the incremental cost is justified vis-a-vis the next best available alternative. There is, however, serious repercussion of this change. Because of increase in scope the cost goes up and the entire planning of resources is thrown out of gear. Whether to agree to the changes in scope has to be decided taking into account the economic constraints - availability of funds and resources in the context of overall planning. On this consideration changes in scope may be avoided.

However, changes in scope during construction may be allowed in situations where, by not making changes in the project feature, the chances of effecting increase in scope are permanently jeopardised.

In case changes in scope have to be accommodated after the approval of the project, the additional works should wherever possible be sanctioned as separate schemes whose costs have only to be arithmatically added to the earlier project to find out the total cost.

When it is not possible to bring up a separate scheme to cover the changes in scope, the estimate of the project with the increased scope should be sanctioned as a "modified project" and not merely as a revised estimate.

(Chapter 11, paragraph 152)

## Preparation of project feasibility reports and estimates

20. No change in the existing administrative procedure to prepare plan estimates at current prices is called for. However, as an instrument of planning it would be unrealistic if no arrangements are made to take notice of the crucial factor of inflation. For this purpose a suitable cushion should be devised which may fit in with the governmental financial mechanism. Approval of a scheme takes some time. Commencement of real construction work after approval also takes time. Then comes the construction period. To cover the increase owing to economic changes over the long period, an appropriate indicator of price rise (i.e. an adjustment factor) should be constructed and the increase so obtained added to the estimate as a 'supplementary provision' for adjusting cost estimates of plan projects.

(Chapter 8, paragraph 102)

21. An Adjustment Factor of 7% per year should be adopted in working out the 'Supplementary provision' for adjusting the cost estimates of plan projects. In applying this factor the estimated cost of the project should be relieved of the cost of land and only 50% of this factor should be considered for the period of actual construction. (As regards cost of land, recommendation no. 26 refers.).

(Chapter 8, paragraph 111)

22. The adjustment factor should be reviewed from time to time after taking into consideration all aspects of the economic situation in the country. For this purpose the Central Water & Power Commission should have a permanent study cell for collection of data and preparation of Construction Cost Index for the works of river valley projects.

(Chapter 8, paragraph 112)

23. To cover cost increase due to changes in design and additional requirements at the time of detailed design and construction which invariably occur in river valley projects because of their complex nature, additional provisions should be made in the estimate prepared at the feasibility report stage under a head which may be called "Margin of error".

(Chapter 12, paragraph 158)

24. 'Margins of error' indicated below are recommended for various types of works. The recommendation is made on the premise that the preliminary designs are based on adequate investigations at the initial stage.

| | |
|---|---|
| Headworks | 10 to 15% |
| Tunnel & other underground works (in Himalayan region) | 30 to 40% |
| Distribution System | |
| i) Primary System (consisting of main canals and branches) | 10 to 15% |
| ii) Secondary System (consisting of distributaries and minors) | 20 to 25% |
| iii) Tertiary System (consisting of minors & water courses) | 25 to 30% |
| Hydro-electric Installations (Civil Works) | 40 to 50% |
| Drainage Works | 20 to 40%<br>(The margin would be on the lower side for alluvial soils and high in case of other types requiring more drainage.) |

(Chapter 12, paragraph 160-165)

25. The margins of error obtaining for different types of works should be constantly studied and periodically reviewed for adoption of any revised standards in future.

(Chapter 12, paragraph 166)

26. A Central Committee consisting of concerned officials may be formed and assigned the task of evolving a standard approach for adopting the rate of compensation for land which would recognise (i) a fair deal to those affected and (ii) prevent any artificial increase in the cost of land.

(Chapter 13, paragraph 172)

27. There is no uniform policy regarding scale of rehabilitation measures. A broad national policy on rehabilitation should be laid down with provisions for reasonable modifications being permissible on the merits of each case.

(Chapter 13, paragraph 178)

28. Once full compensation has been made for the land and property acquired, any additional expenditure incurred towards creating a new and better environment for those displaced on account of construction of the project is purely on social and welfare considerations and is not a proper charge to construction. Although, there may not be any alternative but to charge this to the project cost, it may be excluded for benefit-cost analysis.

(Chapter 13, paragraph 179)

29. Planning for construction equipment should be given due importance right from the stage of formulation and the project report should contain a complete blue-print of construction procedures and types of equipment proposed to be used in the execution of the project.

(Chapter 14, paragraph 210)

30. Realistic assessment of the outputs of indigenous earthmoving equipments should be made while estimating the unit costs.

(Chapter 13, paragraph 188)

31. Alongwith the preparation of the feasibility report for a project, a feasibility plan for drainage should also be made available and cost thereof provided in the estimate.

(Chapter 12, paragraph 165)

32. Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) network may be attempted right from the project formulation stage so that the programmes so drawn up can form part of the project report.

(Chapter 14, paragraph 200)

33. For guarding against inadequate provisions in project estimates, more care should be exercised in framing the estimates by those concerned with their preparation, as also those who check them. Advantage may be taken of the finalised cost figures incorporated in the completion reports of already executed projects. In this context the Committee strongly recommends that the preparation of completion reports, which has not been given adequate importance in the past, should be insisted upon to be finalised within two to three years of commissioning the project.

(Chapter 10, paragraph 141)

34. The set up for technical examination of projects in the C.W. & P.C. needs to be streamlined and suitably strengthened. It has also to be seen if examination of the same aspect in the project report by two departments can be dispensed with to avoid delay.

(Chapter 4, paragraph 44)

35. It is understood that in pursuance of the suggestion made in the report on 'Criteria for Appraising the Feasibility of Irrigation Projects' published by the Planning Commission in 1965, a Working Group was constituted by the Planning Commission comprising irrigation experts, economists and planners for preparing a manual of standard procedures and methods for working out the benefit-cost ratio. It is further understood that the draft manual so prepared is under wide circulation for eliciting comments and suggestions. While finalising the manual the Planning Commission may go into the question of the procedure for assessment of benefits in depth and indicate clearly the data which will be required to be collected for the purpose of working out the benefits and costs, illustrating at the same time the methodology to be followed step by step in arriving at the benefit-cost ratio. The cost of developing land for irrigation when it newly comes to a region should not be missed in working out the B.C. Ratio.

(Chapter 6, paragraph 82)

## Implementation of projects

36. In connection with the setting up of Control Boards for the construction of irrigation and multipurpose projects, the views and recommendations

of the Irrigation Commission as given below are endorsed for acceptance:-

> "We consider that all large inter-State projects and any State project costing Rs. 500 million or more should have a Control Board. Even for projects costing less than Rs. 500 million but which are of a complicated nature, a Control Board would be desirable. To be effective, Control Boards should be delegated the maximum powers and should in turn, be liberal in delegating powers to the Chief Engineers of projects in the interests of efficiency.
>
> In States where several projects are under construction, a single Control Board with standing committees for each project would suffice. This would help to promote the best use of man-power and equipment.
>
> Where a major project receives special financial assistance from the Union Government, the centre should be adequately represented on the Control Board."

(Chapter 14, paragraph 191)

37. For a major river valley project there must be a Chief Engineer or a Project Manager posted exclusively for its execution.

(Chapter 14, paragraph 192)

38. It is essential that the person in charge of execution of a project is vested with appropriate authority - both administrative and financial so that he may discharge his responsibilities unhesitatingly. There is thus a very cogent case for delegating more powers to the Chief Engineer/Project Manager even when there exists a Control Board for overall direction as regards planning and execution. A team of officials including technical officers from various projects in the country may be set up to go into the question of delegation of enhanced powers to the Chief Engineer/Project Manager and his executives and draw up a model for adoption in the projects to be taken up in future.

(Chapter 14, paragraph 193)

39. There should not be too frequent changes in the key personnel entrusted with the execution of the projects.

(Chapter 14, paragraph 194)

40. For a successful implementation of the development programmes, there is a strong need to have competent project managers. To create a nucleus of such experts, senior technical officers who show an aptitude for project management should be earmarked for special training.

(Chapter 14, paragraph 197)

41. A comprehensive institute should be set up in the Centre and preferably in C.W.& P.C. for training in the water resources sector of all officers - engineers, geologists, accountants, planners and managers who are engaged in project works. At the State level also there should be training facilities in the water resources sector for junior officers of the rank of supervisors, junior engineers, etc. The existing facilities like Water Resources Development Centre at Roorkee and Administrative Staff College at Hyderabad should be utilised fully till such time a comprehensive institute at the Centre for training in water resources sector comes up.

(Chapter 14, paragraph 197)

42. The use of all the modern management techniques based on "System" approach in the implementation of river valley projects is strongly advocated.

(Chapter 14, paragraph 198)

43. For the introduction of the modern management techniques it would be necessary to have properly qualified staff in the organisation. Moreover, persons at all levels of management will have to be fully conversant with these techniques. Adequate arrangement should, therefore, be made for the training of project personnel for this purpose.

(Chapter 14, paragraph 198)

44. A detailed plan of work should be chalked out and schedules drawn up visualising each important activity and taking into account the

limitations and inter-relationship of one group of activities with another by the use of modern programming techniques.

(Chapter 14, paragraph 200)

45. It is necessary in case of major projects to adopt the modern systems and techniques of Material Management and Inventory Control.

(Chapter 14, paragraph 201)

46. It is important to establish Cost Engineering Cells on major projects as already advised by the Ministry of Irrigation and Power which will go a long way in controlling costs and keeping the estimates up-to-date.

(Chapter 14, paragraph 206)

47. A Management Information System designed to provide information on cost and time for use by the Project Managers for decision-making be devised.

(Chapter 14, paragraph 207)

48. For exercising efficient financial control during execution of river valley projects, Performance Budgeting system should be adopted.

(Chapter 14, paragraph 209)

49. Ministry of Irrigation & Power may take necessary steps at the highest level to bring pressure on the manufacturers of indigenous equipment which are in both private and public sectors for giving better service to their customers.

(Chapter 13, paragraph 189)

50. In allocation of financial resources irrigation and multipurpose projects should receive very high priority and adequate funds so that all projects approved by the Planning Commission are completed in

optimal time and further escalations in cost due to protracted construction period are avoided.

(Chapter 13, paragraph 185)

51. Advance programmes for stock-piling of construction materials and spare parts should be made very carefully by engineers with experience and foresight.

(Chapter 14, paragraph 218)

52. Some reasonable advance stock-piling of construction material and spare parts should be permitted.

(Chapter 14, paragraph 218)

53. Wherever possible, a cement factory situated near a project requiring a very large quantity of cement for its construction could be linked to the project.

(Chapter 14, paragraph 219)

54. In deciding the agency for execution of project the following policy should be followed:

> In general, for big jobs, execution through departmental agencies should be encouraged.
>
> Projects which are of complex nature and where there is possibility of changes being effected as a result of further investigations during pre-construction stage, should invariably be executed by departmental agency.
>
> Projects which are fairly well defined can be got executed through contractual agencies if suitable contractors come forward.
>
> When work is handed over to a contractor, arrangements could be made to provide him with sources of easy finance, cheaper and quicker supply of materials and other conveniences so that he can execute the work quickly and economically. Such measures would also help remove scarcity of good contractors.

Everything else remaining same, when the project is labour-intensive, it would be better to get it executed through the contractor, while a project which is capital (Machinery) intensive could be carried out departmentally.

(Chapter 14, paragraph 217)

55. For expediting the acquisition of land and to prevent delays in the execution of projects and consequential rise in costs the following recommendations made recently by the Land Acquisition Review Committee set up by the Government of India are endorsed for implementation:-

"(i) The setting up in each State of a Directorate of Land Acquisition under a Member of the State Revenue Board, which would be responsible for land acquisition;

(ii) a regular monthly review of progress at the Collector's level;

(iii) adequate pre-planning for the acquisition of land required by projects and the issue of notifications specifying the project areas. These notifications would be valid for two years within which period the land would have to be acquired;

(iv) prescribing time limits for the Directorate of Land Acquisition to complete acquisition proceedings; and

(v) special powers to deal with specific emergencies."

(Chapter 13, paragraph 171)

56. Special land acquisition officers should be earmarked for major projects so that they can give their undivided attention to the project work.

(Chapter 13, paragraph 171)

# 17. ACKNOWLEDGEMENTS

# 17. ACKNOWLEDGEMENTS

In preparing this report help has come from various sources - from Ministries & Departments, individuals and publications which are hereby acknowledged.

The Committee wants to thank Shri S.K. Jain, Chairman, Central Water & Power Commission and ex-officio Secretary to the Government of India for providing facilities for the meetings of the Committee in the Bikaner House and allowing the services of the officers and staff of C.W. & P.C. for the work of the Committee which was not provided with any secretariat staff.

Thanks are also due to the Geological Survey of India, Indian Agricultural Research Institute, Central Soil Conservation Board, All India Soil & Land Use Survey, Indian Meteorological Department and Central Ground Water Board for furnishing a lot of information about the work done by them which helped in the preparation of this report.

Replies to the questionnaire on project formulation, planning and execution were received from the Governments of Gujarat and Maharashtra; General Manager, Beas Project; and Chief Engineers of Kallada, Pochampad, Ramganga and Kangsabati projects. The Committee appreciates the hard work that had to be put in to furnish the information against the various questions and wishes to very sincerely thank them.

In holding its field meetings at Ramganga, Ukai and Beas-Sutlej Link project sites the Committee was greatly helped by the project authorities. In this connection the Committee wishes to record its appreciation for the assistance and co-operation extended by Sarvashri N.C. Saksena, Engineer-in-Chief, U.P.; K.C. Goyal the then Chief Engineer, Ramganga Project and now Member (P&P), C.W. & P.C. (W.W.); C.C. Patel, Additional Special Secretary and Chief Engineer, Gujarat and S.S. Lamba, Chief Engineer, Beas-Sutlej Link project.

For assisting the Committee in identifying and quantifying the reasons for increase, the Committee takes this opportunity to thank Sarvashri R.G. Patel, I.C. Patel and S.A. Shah, Superintending Engineers, Ukai Project, Gujarat and their supporting staff; Sarvashri P.K. Dey and M.M. Mukhopadhyaya, Superintending Engineers, Kangsabati project, West Bengal and their other engineers; Sarvashri S.N. Lele and M.Y. Shinde, Executive Engineers, Jayakwadi project, Maharashtra and their Deputy Engineers and others. Thanks are also due to the State Governments and the Additional Special Secretary and Chief Engineer, Shri C.C. Patel of Gujarat; Chief Engineer, Shri M.C. Sarwate of Maharashtra and Chief Engineer, Shri D.P. Chatterjee of West Bengal for permitting their officers to assist us in all possible manner in the examination of the project estimates.

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The Chairman and the Members of the Committee specially thank Shri P.C. Mittra, Director of Statistics, C.W. & P.C. who took keen interest in the deliberations of the Committee and made significant contribution in drafting chapters 2 to 5 of the report.

Although he was a colleague on the Committee, the Chairman and the Members of the Committee would still specially like to record their appreciation of the work done by Shri B. Sen, Member-Secretary of the Committee. His life long experience in engineering costing has permeated into every field of the Committee's work. His masterly handling of the chapter on 'cost escalation due to rise in prices' and the boldness with which he has brought out the escalation factor has given a new dimension to the approach towards proper estimating. The Committee sincerely thanks him for his outstanding contribution in the Committee's work.

The team of officers and staff helping the Member Secretary in the Committee's work also deserves special thanks for their sincere and hard work. In this connection particular mention need be made of the valuable and untiring help rendered by Shri B.L. Jatana, then a Deputy Director (Rates & Costs), C.W & P.C. now Executive Engineer, Irrigation Department, U.P. Mention may also be made of Sarvashri K.A. Patel, M.G. Ajwani, O.P. Kumra, K.A. Ramrakhyani and R.D. Saxena, Deputy Directors, C.W. & P.C; Shri M. Das, Assistant Director; Shri M.K. Rajgopal, Extra Assistant Director; Sh. G. Ravindra Nath, Statistical Assistant; Shri K.K. Attrey, Personal Assistant; Shri Jagmohan Lal, Senior Draftsman; Shri D.L. Gaur, Typist and Shri Moti Ram Garg, Tracer.

The various books and publications consulted are mentioned below:

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# APPENDICES

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Appendix 1

(TO BE PUBLISHED IN THE GAZETTE OF INDIA PART I SECTION I)

No. DW.II-34(2)/71
GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION AND POWER

New Delhi, the 25th Jan., 1972.

## RESOLUTION

Since Independence, a large number of irrigation and multipurpose projects have been taken up for construction in the country. While the benefits of irrigation accruing from these projects have greatly helped in increasing agricultural production in the country, the mounting costs and the frequent revision of the project estimates and consequent delay in the completion of the projects and accrual of the benefits therefrom have been causing great concern to Government. There has been no scientific investigation so far into the causes leading to the large number of revisions in project estimates. The Government of India, have, therefore, decided to refer this question to a Committee of experts so that a sound policy could be framed for formulation and implementation of future irrigation and multipurpose projects.

2. The Committee will consist of the following:

| | | |
|---|---|---|
| *1 | Shri J.P. Naegamvala, Member (P&P), C.W. & P.C. (WW) | Chairman |

|  |  |  |  |
|---|---|---|---|
|  | 2. | Shri N.C. Saksena, Engineer-in-Chief, U.P. | Member |
| 1/ | 3. | Shri V. Suryanarayana, Chief Engineer (Projects), Andhra Pradesh. | Member |
| ** | 4. | Shri C.C. Patel, Chief Engineer (Irrigation Projects) & Joint Secretary to Government, PWD, Gujarat. | Member |
|  | 5. | Shri U.K. Verma, Chief Engineer, Gandak Project, Bihar. | Member |
| *** | 6. | Dr. K.C. Thomas, Chief Engineer, Himachal Pradesh. | Member |
|  | 7. | Shri B.A. Ansari, Chief Engineer, Hydro-Projects, Maharashtra. | Member |
|  | 8. | Shri S.S. Apte, Chief Engineer (Irrigation), Maharashtra. | Member |
|  | 9. | Dr. N.D. Rege, Jt. Commissioner (Soil Conservation & Water Management), Min. of Agriculture. | Member |
| 2/ | 10. | A well known economist. | Member |
|  | 11. | Shri Prem Kumar, Member (Accounts), Gujarat State Electricity Board. | Member |
|  | 12. | Shri O.P. Chadha, Chief (Irrigation), Planning Commission, New Delhi. | Member |
|  | 13. | Shri S.T. Veeraraghavan, F.O., Ministry of Finance. | Member |
|  | 14. | Shri B. Sen, Director (R&C), C.W. & P.C. (WW), New Delhi. | Member-Secretary |

3. The Committee will examine:

a) the adequacy or otherwise of the existing arrangements for the investigation and formulation of irrigation and multipurpose projects, preparation of feasibility reports and estimates thereof and construction programme including assessment of benefits;

b) the reasons for rise in the estimated costs of projects leading to their frequent revisions and recommend:

c) modification or revision in procedures for more realistic preparation of project feasibility reports and estimates as also improvement in the present system of implementation of projects to ensure their completion within the sanctioned estimated costs and according to the scheduled programmes of completion.

4. The Committee may invite, as and when necessary, other officers to participate in its discussion; it may visit irrigation and multipurpose projects in the States, if considered necessary. The Committee will submit its report by 30th June, 1972.

Sd/- A.S. Sharma
( A. S. SHARMA )
Joint Secretary to the Govt. of India.

No. DW.II-34(2)/71

New Delhi
the 25th January, 1972.

ORDER

Ordered that the Resolution be published in the Gazette of India, Part I, Section I.

Ordered also that a copy of the Resolution be communicated to all Ministries/Departments of the Government of India, all State Governments/Administrations of Union Territories and the Chairman/Members of the Committee.

Sd/- A.S. Sharma
( A.S. SHARMA )
Joint Secretary to the Govt. of India.

To

The Manager,
Government of India Press,
Faridabad.

References:

1/ Replaced by Shri S. Gopalan, Chief Engineer (P.W.D.), Major Irrigation and General, Andhra Pradesh w.e.f. 1.5.72 (vide Resolution of even number dated 10.10.1972).

2/ Dr.K. Venugopal, National Council of Applied Economic Research, New Delhi (vide Resolution of even umber dated 29.3.1972).

* Now Member (WR), C.W.& P.C. (WW) and ex-officio Joint Secretary to the Government of India, Ministry of Irrigation & Power.

** Now Chief Engineer (Irrigation Projects) and Additional Special Secretary, P.W.D., Gujarat.

*** Now Chairman, Himachal Pradesh State Electricity Board.

## Cost Escalation of Major Irrigation & Multipurpose Projects

(Rs. Crores)

| Project | Date of sanction | First estimate 1/ | Revised estimate 2/ | Percentage rise $\frac{(4)-(3)}{(3)} \times 100$ |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 1. **ANDHRA PRADESH** | | | | |
| 1.1 Kaddam | I Plan | 5.6 | 8.4 | 49 |
| 1.2 Nagarjunasagar | 22.9.60 | 91.1 | 250.0 | 172 |
| 1.3 Pochampad | 7.8.64 | 40.1 | 75.7 | 89 |
| @ 1.4 Tungabhadra H.L.C. St.I | 9.4.59 | 13.0 | 24.4 | 88 |
| @ 1.5 Tungabhadra H.L.C. St.II | 6.1.67 | 14.6 | 19.8 | 36 |
| @ 1.6 Tungabhadra | I Plan | 33.4 | 65.0 | 94 |
| @ Covers Andhra Pradesh and Mysore. | | | | |
| 2. **BIHAR** | | | | |
| 2.1 Chandan Reservoir | 8.1.63 | 3.5 | 10.4 | 194 |

1/ As approved.

2/ From annual plan discussions 1972-73.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| £ 2.2 Gandak | 13.7.61 | 52.0 | 219.0 | 321 |
| 2.3 Kosi | 1956 | 44.8 | 111.6 | 150 |
| 2.4 Rajpur Canal | 30.11.61 | 4.7 | 9.7 | 108 |
| 2.5 Sone Barrage Remodelling & Link Canal | 14.5.60 | 14.4 | 16.1 | 11 |
| 2.6 Sone H.L.C. | 3.6.68 | 8.8 | 13.5 | 53 |
| $ 2.7 Western Kosi Canal | 30.11.61 | 13.5 | 36.9 | 173 |

£ Covers also U.P. and Nepal. Rise in Bihar estimate including Nepal benefits is 345%. Rise in U.P. estimate excluding Nepal is 238%.

$ Covers also U.P. and Nepal. Although approved in 1961 work was taken up in 1972.

3. GUJARAT

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 3.1 Kakrapar | 1949 | 6.3 | 18.6 | 202 |
| 3.2 Mahi St.I | 1948 | 4.3 | 24.6 | 480 |
| 3.3 Mahi St.II (Kadana) | 12.12.66 | 16.3 | 21.0 | 29 |
| 3.4 Narmada (Broach) | 5.8.60 | 43.1 | 107.9 | 150 |
| 3.5 Ukai | 19.8.61 | 58.2 | 108.6 | 86 |

4. HARYANA

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| @ 4.1 Gurgaon Canal | 7.2.66 | 8.3 | 13.5 | 63 |

@ Covers Haryana and Rajasthan.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 4.2 W.J.C. Remodelling | I Plan | 3.0 | 12.5 | 314 |
| 5. KERALA | | | | |
| 5.1 Chitturpuzha | 1.12.64 | 0.7 | 5.4 | 701 |
| 5.2 Kallada | 4.2.66 | 13.3 | 45.0 | 230 |
| 5.3 Kanhirapuzha | 24.3.64 | 3.7 | 9.3 | 154 |
| 5.4 Kuttiadi | 8.4.64 | 5.0 | 12.6 | 154 |
| 5.5 Pamba | 24.3.64 | 3.8 | 17.9 | 367 |
| 5.6 Pazhassi | 8.4.64 | 4.4 | 13.2 | 199 |
| 5.7 Periyar Valley | 1.4.57 | 3.5 | 11.5 | 230 |
| 6. MADHYA PRADESH | | | | |
| 6.1 Barna | 23.2.60 | 5.6 | 9.3 | 67 |
| £ 6.2 Chambal Stage-I | I Plan | 34.5 | 85.0 | 146 |
| £ 6.3 Chambal Stage-II | 17.5.60 | 9.4 | 14.2 | 50 |
| 6.4 Hasdeo | 5.9.62 | 3.3 | 10.2 | 207 |
| 6.5 Hasdeo RBC | 20.6.67 | 5.0 | 11.4 | 129 |
| 6.6 Tawa | 5.8.60 | 20.2 | 48.0 | 137 |
| 7. MAHARASHTRA | | | | |
| 7.1 Bagh | 1.3.67 | 5.8 | 10.6 | 83 |
| 7.2 Bhima | 24.3.65 | 42.6 | 62.3 | 46 |

£ Covers also M.P. and Rajasthan.

| 1 | | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 7.3 | Girna | 20.3.60 | 12.8 | 15.0 | 18 |
| 7.4 | Itiadoh | 11.3.65 | 7.3 | 8.5 | 16 |
| 7.5 | Jayakwadi St.I | 3.2.65 | 38.5 | 74.4 | 93 |
| 7.6 | Khadakwasla St.I | 20.1.60 | 11.6 | 29.7 | 152 |
| 7.7 | Krishna | 17.2.66 | 27.7 | 49.8 | 80 |
| 7.8 | Kukadi St.I | 14.10.68 | 17.9 | 27.5 | 54 |
| 7.9 | Mula | 29.1.57 | 8.7 | 21.6 | 149 |
| 7.10 | Purna | 21.8.61 | 12.8 | 16.6 | 29 |
| 7.11 | Pus | 4.12.64 | 3.7 | 5.1 | 49 |
| 7.12 | Upper Godavari | 16.6.67 | 14.2 | 14.3 | - |
| 7.13 | Warna | 22.1.66 | 31.1 | 57.0 | 84 |
| 8. | MYSORE | | | | |
| 8.1 | Bhadra | 1947 | 7.9 | 40.7 | 417 |
| 8.2 | Ghataprabha St.I | June, 1949 | 5.5 | 6.9 | 27 |
| 8.3 | Ghataprabha St.II | 24.10.59 | 13.2 | 48.5 | 268 |
| 8.4 | Kabini | 9.4.58 | 2.5 | 35.0 | 1300 |
| 8.5 | Malaprabha | 5.8.63 | 19.2 | 67.7 | 253 |
| 8.6 | Upper Krishna St.I | 21.11.63 | 58.2 | 116.7 | 100 |

| 1 | | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 9. | **ORISSA** | | | | |
| 9.1 | Hirakud Stage I | 1947 | 47.8 | 67.8 | 42 |
| 9.2 | Mahanadi Delta | I Plan | 14.9 | 68.4 | 358 |
| 9.3 | Salandi | 8.10.59 | 4.7 | 14.3 | 206 |
| 10. | **PUNJAB** | | | | |
| @ 10.1 | Beas Unit I | 4.10.63 | 96.7 | 180.0 | 86 |
| @ 10.2 | Beas Unit II | 6.10.69 | 163.0 | 193.0 | 18* |
| 11. | **RAJASTHAN** | | | | |
| 11.1 | Rajasthan Canal St.I | 4.7.57 | 66.5 | 119.0 | 89 |
| 12. | **TAMILNADU** | | | | |
| 12.1 | Chittarpattana-mkal | 6.4.64 | 6.7 | 6.8 | 2 |
| 12.2 | Parambikulam Aliyar | 10.8.62 | 24.9 | 50.1 | 01 |

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@ Covers Haryana, Punjab and Rajasthan.

* Percentage rise has come low because the first estimate is reckoned from the date sanctioned by the Planning Commission (which is the base of comparison) although this was a revised estimate of one sanctioned by the State Government earlier for a lower figure of Rs.75.34 crores.

| 1 | | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 13. | **UTTAR PRADESH** | | | | |
| 13.1 | Improvement of Lower Sarda Canal System (St.I) | 21.8.68 | 64.8 | 64.8 | |
| 13.2 | Ramganga | 8.7.59 | 39.8 | 127.9 | 222* |
| 14. | **WEST BENGAL** | | | | |
| 14.1 | Kangsabati | 28.1.61 | 25.3 | 46.0 | 82 |
| 14.2 | Mayurakshi | 1946 | 15.5 | 20.5 | 32 |

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* The base of comparison is the first estimate approved by the Planning Commission in 1959. A better estimate was prepared in 1961 after taking into account possibility of severe earthquake, higher floods as also increase in scope and this amounted to Rs.67.98 crores which was sanctioned by the State Government. Compared to this, the rise in the revised estimate would be 90%.

Appendix 3

# EXPERT COMMITTEE EXAMINING THE INCREASE IN COSTS OF IRRIGATION AND MULTIPURPOSE PROJECTS

## Questionnaire on project formulation, planning and execution

### 1. GENERAL

1.1 Name of project

1.2 Name of river

1.3 Location

1.4 Date when the scheme was first approved by the Planning Commission

1.5 Programme of construction

1.51 Stipulated period of construction as per original report

1.52 Actual date when started (mention separately for preliminary works like approach roads, camps and for actual works)

1.53 Expected date of completion

1.6 Designation and address of the officer in charge of the execution of the project

## 2. PROJECT FORMULATION

### 2.1 Preliminary Investigation

2.1.1 Give a complete history of the preliminary investigations done for the project indicating when the investigations were first initiated, who carried out this work, whether any alternative proposals were considered, who decided about the final proposal for detailed investigations, when the preliminary investigations were completed, etc.

### 2.2 Feasibility studies for the first project report approved by the Planning Commission

#### 2.2.1 Investigations & Design - agencies and norms

2.2.1.1 When were the detailed investigations taken up/and completed for preparation of the project report?

2.2.1.2 Were there any norms laid down regarding quantum of investigation work to be done for preparation of the project report? If so, give details.

2.2.1.3 Were these investigations carried out by some existing maintenance/construction unit or were these done by some separate circle/division created for the purpose?

2.2.1.4 Was the investigating unit properly equipped with personnel and equipment?

2.2.1.5 Was the investigation work done under the guidance of any experts in this field? If so, give details.

2.2.1.6 Who prepared the preliminary designs for the project report? Were these done by the investigation unit or by a separate design organisation? Was any second opinion obtained regarding adequacy of designs and layout for major components of the project, from any Consultants/Specialists?

### 2.2.2. Topographical Surveys

2.2.2.1 Indicate the magnitude and extent of surveys carried out for the purpose of preparing the project report. Was the help of the Survey of India obtained for establishing primary grid, special surveys by aerial photography, etc? Give details.

2.2.2.2. Were longitudinal and cross sections taken along the proposed alignments for all the main canals and branches indicating soil classification as well? If so, give details.

### 2.2.3. Geological Investigations

2.2.3.1 Were geological investigations for establishing the foundation conditions for major structures (dam, headworks, tunnels, etc.) done under the guidance of a Geologist? Was the Geologist employed by the Department or drawn from the Geological Survey of India?

### 2.2.4 Hydrological Investigations

2.2.4.1 Were the studies for water availability and working out the design flood based on detailed hydrological investigations? What were the periods of observation for rainfall and discharge measurement on which such studies were based?

### 2.2.5 Soil Surveys

2.2.5.1 Were detailed soil surveys carried out in the area to be commanded by canal system? Briefly describe the extent of work done in this connection.

2.2.5.2 Who carried out these surveys? Was this done by an agronomist? Wherefrom were the services of agronomist obtained?

2.2.5.3 Was the cropping pattern fixed keeping in view the soil classification? Was this done as per advice of agricultural experts? Mention the arrangements made in this connection.

### 2.2.6 Construction Material Surveys

2.2.6.1 Were detailed surveys carried out for locating the sources of construction materials and establishing the quantities available? Were suitabilities of these materials established by conducting necessary tests?

### 2.2.7 Cost Estimates

2.2.7.1 What was the total estimated cost of the first project estimate approved by the Planning Commission? What was the base year for cost estimation?

2.2.7.2 Were the cost estimates based on any schedule of rates? If so, indicate the schedule and the base year for which it was valid.

2.2.7.3 Were all the item rates available from the schedule of rates? If not, what was the basis of adopting them.

2.2.7.4 Was the construction procedure exactly visualised while framing the estimate? If so, indicate this in brief.

2.2.7.5 Was the estimate for land acquisition cost framed in consultation with the Revenue authorities? If not, indicate the basis on which land rates were fixed.

2.2.7.6 Was the provision for rehabilitation made on the basis of any guidelines prescribed? Indicate the basis for making this provision.

2.2.7.7 What was the basis of estimation of costs for Canals and Canal structures? Were these based on detailed design/typical estimates/lump sum provisions?

2.2.7.8 How was the cost of distributaries and minor estimated? Was this based on actual cost obtained in the adjoining areas in terms of cost per acre or on rate estimated for typical channels?

### 2.2.8 Construction Planning

2.2.8.1 What were the periods of construction (indicate dates if possible) stipulated in the first approved project report for major structures like dam, barrage, canals, distributaries, etc.?

2.2.8.2 Was the construction programme prepared on the basis of detailed planning, ascertaining whether the targets could be physically achieved, whether the necessary construction equipment and spares could be procured in time and whether the funds for the job would be available? Was the Finance Department consulted regarding availability of funds for the scheme?

2.2.8.3 Was the requirement of plant and equipment worked out in detail for making necessary provisions in the project estimate? Was this done visualising the construction procedures involved and by properly phasing the quantities of work to be done in each year?

2.2.8.4 Were the equipment planning and programme planning done by experienced persons/experts in construction? If so, indicate wherefrom they were obtained and what was their previous experience. Was the help of any Consultants obtained for this purpose? If so, who were these Consultants?

2.2.8.5 Was the requirement of Foreign Exchange, if any, for equipments to be imported worked out in detail?

### 2.2.9 Project Feasibility

2.2.9.1 What was the yardstick adopted for determining the feasibility of the scheme? Were any standards laid down for adjudging the feasibility?

2.2.9.2 Indicate the percentage, financial return/B.C. ratio for the project as worked out, depending upon the yardstick adopted. Furnish details of such calculations.

2.2.9.3 In case the feasibility of the original scheme was determined on the criterian of financial return, please indicate what the B.C. ratio would have been then if this was the criterian to be followed. Please give the details of calculations for B.C. ratio so worked out.

2.2.9.4 How were the data for working out the financial return/Cost Benefit ratio collected? Was the help of agricultural experts taken in estimating the quantities of farm produce, expenditure on farm inputs, etc.

2.2.9.5 Were the calculations for B.C. ratio/financial return checked by the Finance Department?

## 3. PRE-CONSTRUCTION INVESTIGATIONS & PLANNING

3.1 Were any investigations done during period between approval of project and actual start of construction? If so, mention in detail the investigations done during this period.

3.2 Was there any change in the design and layout of major components as a result of the further investigations done? If so, give details indicating reasons for such changes.

3.3 Were there any changes in the estimate as a result of further investigations? If so, give details of changes made in the estimate. Was the revised estimate submitted to Planning Commission? If so, when?

3.4 Was any detailed construction planning done during this period? Was any action initiated regarding procurement of equipment and material? If so, indicate in brief.

3.5 Was any action taken to build up any organisation for detailed designing and execution of the project? If so, give in brief the set up of the organisation created.

3.6 3.6 When was the action for acquisition of land for the project initiated? Indicate dates for start of land acquisition proceedings and dates when actual possession was obtained for —

(i) Construction Camps

(ii) Headworks (like Dam, Barrage, etc.)

(iii) Canals

(iv) Borrow areas

3.7 Were any arrangements made for the rehabilitation of persons to be displaced due to this scheme? If so, indicate in brief the work done for the purpose. Was there any difficulty in this work?

3.8 Please indicate work done/problems encountered (if any) during the period, which are not covered by information asked for above

## EXECUTION

### 4.1 Programme

4.1.1 Please give a bar chart showing progress of works executed so far for each important component of the scheme like headwork, tunnel, spillway, main canals & branches, distributaries, etc. indicating the date of start and comparing the actual progress vis-a-vis the stipulated schedule of construction given in the original (i.e. the first approved) project report?

4.1.2 Was there any delay in the acquisition of land required for the project? If so, indicate the cause of delay and its impact on original construction schedule in terms of delay in months.

4.1.3 Was there any delay in the construction of communication to the site of work and other facilities (e.g. roads, railway, colony, electricity, telephone, etc.) according to schedule? If so, mention the period of delay in each case, the cause of delay and the overall impact on original construction schedule (delay in months).

4.1.4 Were there any major changes in the designs and specifications of works during execution? If so, please indicate the reasons for such changes along with their impact on the original construction schedule (delay in months).

4.1.5 Was there any delay in procurement of necessary construction machinery and equipment? If so, indicate the cause and impact on the original construction schedule.

4.1.6 Was there any delay in the procurement of permanent equipment like Turbines & Generation equipment for Power House? If so, state the reasons for delay and its impact on the overall construction schedule (delay in months).

4.1.7 Was there any difficulty in the procurement of construction materials like cement, steel, which adversely affected the overall schedule of construction? If so, indicate the causes of such delays and their impact on the original construction schedule (delay in months).

## 4.2 Revision of Estimates

4.2.1 Was any revision of the original estimate found necessary in course of execution of the scheme? If so, please furnish the following details:

| | Year of Revision | Estimated Cost | Date of approval by Planning Commission |
|---|---|---|---|
| (i) | .......... | .......... | ............... |
| (ii) | .......... | .......... | ............... |

4.2.2 What is the latest assessment about the cost of the scheme and expected date of completion of the project?

4.2.3 Was there any increase in the estimate due to increase in the scope of the project like providing for flood control? If so, why could this work not be executed as a separate scheme?

4.2.4 Is there any change in the B.C. Ratio due to revision of the estimate? If so, indicate the revised B.C. ratio for the project, the basis of assessment of benefits assumed for the revised B.C. ratio along with calculations.

4.2.5 Were there any factors, other than escalation in prices of labour and materials which were responsible for increase in the cost of the project? If so, indicate these in brief.

## 4.3 Administrative Set-up

4.3.1 Was the project executed by a Chief Engineer, exclusively employed for the project? Was this done under the administration and direction of a Control Board?

4.3.2 Was any difficulty experienced at any time regarding recruitment and posting of personnel required for execution of the project? If so, whether it had any adverse effect on the overall construction schedule and what was the delay on this account?

4.3.3 Were there any instances of delays on account of delay in taking decisions? If so, please indicate details.

## 4.4 Executing Agency

4.4.1 Were the works executed through contractors or through departmental agency or both? In case the work was done through contractors, indicate the names of contractors for major works.

4.4.2 Was there enough competition and were good contractors available for executing small works?

4.4.3 Were contractors available for doing earthwork by machine? (This is for jobs involving construction of heavy earthen embankments and big canals).

4.4.4 How did the bids given by the contractors compare with the estimated rates? Please indicate the percentage of variation in the bids accepted compared to the estimated costs (in the first approved estimates) for the following works of the project —

(i) Headworks (dam, barrage, weir)

(ii) Tunnels

(iii) Power House

(iv) Main Canal

(v) Other important works (if any).

4.4.5 Briefly comment on the performance of the contractors employed (for main works) so far as keeping up to targets is concerned. Was there any instance of works being withdrawn due to poor performance of a contractor? If so, give details.

4.4.6 Were any difficulties experienced because of any defects in the contracts awarded? Please give brief details of such instances, if any.

## 4.5 Funds

4.5.1 Was there any delay in getting funds in time? If so, what was the delay on this account in the construction of the scheme?

4.5.2 Please furnish the following information:

| Year | Funds asked | Funds allotted | Funds actually utilised | Reasons for variation |
|---|---|---|---|---|
| ..... | ...... | ....... | .......... | ............ |
| ..... | ...... | ....... | .......... | ............ |
| ..... | ...... | ....... | .......... | ............ |

### 4.6 Project Management & Control

4.6.1 Was there any system of regular Financial Stock-taking of the Project? If so, briefly indicate the system followed. In case any standard proformae were used, please enclose copies of the same.

4.6.2 Was there any system of inventory control? What was the organisation for maintenance of stores? Briefly describe the arrangement.

4.6.3 Was there any cost cell set up for evaluation of construction costs?

## 5. EXPERIENCE OF PROJECT EXECUTING AUTHORITY

5.1 Were any special problems faced during execution of the works? If so, give details.

5.2 From the experience in this project, please give suggestions for improvements in project execution with a view to prevent increase in costs.

Appendix 4

## JAYAKWADI, RAMGANGA, UKAI, BEAS-SUTLEJ LINK, KALLADA, KANGSABATI

### [BRIEF SALIENT FEATURES]

### JAYAKWADI PROJECT - STAGE-I, MAHARASHTRA

The Jayakwadi Project envisages the utilisation of waters of river Godavari for providing irrigation benefits to Aurangabad, Parbhani, Dhir and Nanded districts of Maharashtra. For this purpose it is proposed to create reservoirs along the river near paithan and along its tributary - Sindhphana near Majalgaon by constructing dams and taking off three canals, two from paithan reservoir - one each on either bank and from right bank of Majalgaon reservoir, which would irrigate an area of 6.85 lakhs acres. The scheme is to be executed in two stages. At present, execution of Stage I of the scheme, which is to provide irrigation facilities to an area of 3.5 lakhs acres is in progress.

Works envisaged under Stage-I of the scheme are:

i) A 120 ft. high earth dam with a masonry spillway near Paithan on Godavari River which would create a reservoir with gross and live storage capacities of 102.73 TMC and 76.67 TMC, respectively.

ii) Left Bank Canal starting from the paithan dam, 115 miles in length to command gross and net irrigable areas of 5,04,000 acres and 3,50,000 acres, respectively.

The dam is to be constructed to its full capacity under the first stage itself in order to avoid construction problems. However, it is proposed to utilise only 36.86 TMC of storage for irrigation in the Stage I.

## RAMGANGA RIVER PROJECT, U.P.

Ramganga River Project is a multipurpose project aimed at utilisation of waters of river Ramganga for irrigation and power generation. For this purpose, it is proposed to store the water by constructing a dam across the river near Kalagarh in District Garhwal, U.P. The water stored would be let out through a power station located at toe of the dam for power generation. Thereafter, the water so released in the river would be picked up by constructing a barrage across Ramganga river at Hareoli, 16 miles downstream of Kalagarh and diverted to a Feeder Channel of 4750 cusecs capacity. The Feeder Channel would discharge the water into river Ganga at a point upstream of Garhmukteswar. The supplies in the river Ganga so augmented would be picked up by the existing weir at Narora and utilised for irrigation through the existing Lower Ganga Canal system. In order to take up the increased discharge, this canal system would be modified and new channels constructed, mostly in Fathepur and Allahabad districts to bring new areas under irrigation. Also the water available will be utilised for intensification of irrigation in areas already covered by the existing system. With the availability of more water at Narora, as a result of diversion from Ramganga, supplies to Lower Ganga Canal from Upper Ganga Canal would be stopped and water so saved would be utilised for intensifying and picking up new areas for irrigation on Upper Ganga Canal and Agra Canal.

The project would provide irrigation benefits to an area of 16.28 lakh acres - 8.17 lakh acres by intensification on the existing canal systems and 8.11 lakh acres by construction of new channels. 450 million kWh power would be generated annually. It is further proposed to supply 200 cusecs of water to Delhi Administration. Construction of following features is envisaged under the scheme:-

Dam and appurtenant works at Kalagarh, consisting of -

i) a 125.6 metre high earth and boulderfill dam 3.2 km. upstream of Kalagarh for storing 1.78 million acre ft. of water.

ii) 72.2 metre high earth and boulderfill dam across a saddle.

iii) Two diversion tunnels, 31 ft. finished diameter, concrete lined, one of which would be used as 'Power tunnel'.

iv) A chute spillway with a discharge capacity of 2,80,000 cusecs.

v) An auxiliary spillway with a discharge capacity of 67,500 cusecs.

vi) A power house with 3 units of 66 MW each, located at toe of the main dam.

2. A barrage at Hareoli across Ramganga river, 16 miles downstream of Kalagarh with a waterway of 408 metres, consisting of 17 barrage bays of 18 metres, each and 3 undersluice bays.

3. Feeder Channels:

i) 74 km. long feeder channel with a discharge capacity of 135 cum./sec. (4750 cusecs) taking off from the barrage and discharging into river Ganga opposite Garhmukteswar.

ii) 34 km. along sub-Feeder with a discharge capacity of 6.8 cum./sec. (240 cusecs) for feeding the existing Ramganga lift canal by gravity flow.

4. Construction of new channels totalling to about 1330 miles in length and remodelling of existing channels of Lower Ganga Canal System, Upper Ganga Canal System, Agra Canal and Mat branch.

## UKAI DAM PROJECT, GUJARAT

Ukai Project envisages the utilisation of waters of river Tapi for irrigation and power generation. For this purpose it is proposed to construct a 225 ft. high earth-cum-masonry dam across the river near village

Ukai in Sonegadh Taluka of Surat district to store 6.90 million acre ft. of water. A canal would take off from the reservoir on the left bank and part of the water would be let out to be picked up at existing Kakrapar weir located 16 miles downstream of dam. The water would then be taken through the existing canal on the right bank which would be remodelled upto the point when a new canal would take off for providing irrigation in the area. This will firm up irrigation in 5.62 lakh acres of land under the existing Kakrapar weir and will bring 3.76 lakh acres of new area under irrigation. It is proposed to have a power house located at toe of the dam having 4 units of 75 MW each. It will generate on an average 1060 million units annually. It is also proposed to avail of seasonal flows for generation of power by constructing a canal power house at Left Bank Canal regulator in future. Apart from irrigation and power generation, the scheme would afford flood protection to Surat city and adjoining areas.

The following works are envisaged under the project:

1. A rolled-fill earth dam, 225 ft. high in five reaches having a total length of 13314 ft. involving placement of 825.16 mcft. of earthwork.

2. A 2950 ft. long masonry spillway on left flank with a discharge capacity of 8.00 lakh cusecs.

3. A 45 mile long Left Bank Canal taking off from the reservoir with a head discharge of 1180 cusecs.

4. A 60 mile long canal on the right bank taking off from the existing Kakrapar Right Bank Canal, which in turn, takes off from the existing weir at Kakrapar, 16 miles downstream of Ukai, having a head discharge capacity of 1275 cusecs.

5. Main power house located at the toe of dam having an installed capacity of 4 units of 75 MW each.

## BEAS PROJECT, UNIT-I (BEAS-SUTLEJ LINK)

### In Himachal Pradesh

Beas-Sutlej Link is a power-cum-irrigation project. It envisages the diversion of Beas waters into the river Sutlej through a combination of tunnels and an open channel. It would make use of a fall of about 1000 ft. which is available at its tail at Dehar and about 400 ft. at Bhakra for generation of electric power. The river supplies so diverted would also enable extension of irrigation to the arid areas in the south and south-west of erstwhile Punjab (now Punjab and Haryana), besides improving irrigation facilities on the existing Bhakra areas. The project has been so conceived that it fits into what may be called the 'Master Plan' for harnessing the irrigation and power potential of the three eastern rivers namely Ravi, Beas and Sutlej.

The scheme would create an additional firm power potential (made up of power at Dehar power plant and extra power at Bhakra) of 412 MW at 100% load factor. Three million eight hundred and twenty thousand acre feet of water would be diverted to river Sutlej out of which 1.63 million acre ft. would be released back to Beas for utilisation on Harike canals, taking off downstream of the confluence of Beas and Sutlej. The balance quantity i.e. 2.19 million acre ft. would be available to canals off-taking from Ruper which would provide irrigation for culturable commanded area of 1.3 million acres in Punjab and Haryana. The following works are envisaged under the scheme:-

(i) Pandoh Tunnel –
a 200 ft. high earth-cum-rockfill diversion dam at Pandoh

(ii) Pandoh-Baggi
a 25 ft. dia. 8.2 miles long tunnel of 9000 cusecs capacity

(iii) Sundernagar Hydel Channel -
a 7.1 miles long hydel channel of 9000 cusecs capacity in head reach reducing to 7,500 cusecs in the tail reach

(iv) Sundernagar Balancing Reservoir -
a balancing storage of 3,000 acre ft. capacity near Sundernagar

(v) Sundernagar - Sutlej Tunnel -
a 28 ft. dia. power tunnel, 7.6 miles long with a 22 ft. dia. 970 ft. long Bharari By-pass

(vi) Dehar Power Plant -
a power plant on the right bank of the river Sutlej with an installed capacity of 4 units of 165 MW each in the first stage and 2 units of suitable capacity in the second stage.

## KALLADA PROJECT, KERALA

The Kallada project envisages the utilization of waters of the river Kallada for providing irrigation benefits to the area between the Achencoil river on the north and the Ithikara river on the south in the taluks of Pathanamthitta, Kunnathur, Mavelikkara, Karunagapally, Karthigapally, Kottarakara, Quilon and Pathanarpuram. For this purpose it is proposed to construct a reservoir on the Kallada river near Parappar with a storage capacity of 18,500 mcft. to provide irrigation facility to an area of 130,000 acres. The works envisaged under the scheme are -

(i) a masonry dam across the river Kallada at Parappar 1100 ft. long and 241 ft. high.

(ii) a pick-up weir and sluices at Ottakkal about three miles downstream of the dam.

(iii) a right bank canal 42 miles long and 1380 cusecs capacity to serve 80,000 acres lying between the Achencoil and the Kallada rivers.

(iv) a left bank canal 43 miles long and 960 cusecs capacity to serve 50,000 acres lying between the Kallada and the Ithikara rivers.

(v) provision for penstock pipes for installation in future of a power house with an installed capacity of 10,000 kW.

## KANGSABATI PROJECT, WEST BENGAL

The Kangsabati project envisages the utilization of waters of the river Kangsabati for providing irrigation benefits to Bankura Midnapur and Hooghly Districts of West Bengal. For this purpose it is proposed to construct two Dams, one on the River Kangsabati and other on Kumari, a tributary of the Kangsabati near Ambikanagar and to provide irrigation facilities to an area of 8.42 lakh acres. The works envisaged under the scheme are:

(i) a 135 ft. high earth dam on the river Kumari and a 125 ft. high earth dam on the river Kangsabati with a saddle spillway on the left dyke of the river Kangsabati which would create a reservoir of gross storage capacities of 8.50 lakh acre ft. and live storage capacity of 7.30 lakh acre feet.

(ii) a left bank canal 48 miles long, starting from Kangsabati left dyke head-regulator to command a gross irrigable area of 7.90 lakh acres and a net of 6.30 lakh acres.

(iii) a right bank canal, 90 miles in length taking off from the Kumari Dam to command a gross irrigable area of 2.66 lakh acres and a net of 2.12 lakh acres.

## Appendix 5

# STATISTICAL INDICATORS

The following statistical indicators relevant to the work of construction of irrigation and multipurpose projects would show the trend of rising costs:-

1. Wholesale price index : All commodities

   (Source : Economic Adviser, Ministry of Industrial Development)

   Base : 1961-62 = 100 Data : 1962-1972

2. Fuel, Power, Light & Lubricants: Wholesale price index

   [Source : as in (1)]

   Base : 1961-62 = 100 Data : 1962-1972

3. Cement : Wholesale price index

   [Source : as in (1)]

   Base: 1961-62 = 100 Data : 1962-1972

4. Iron & Steel manufacture: Wholesale price index

   [Source : as in (1)]

   Base : 1961-62 = 100 Data: 1962-1972

5. Average annual earnings of Factory Employees

   (Source : Labour Bureau, Ministry of Labour,
   Employment & Rehabilitation)

   Base : 1961 = 100 Data: 1962-1972

6. Index Number of imports of average unit declared value of 'Machinery other than Electrical .

(Source: Director General of Commercial Intelligence &
Statistics, Ministry of Foreign Trade)

Base: 1958 = 100 Data : 1961-1969
Base: 1961 = 100 Data : 1962-1969

## STORY OF WHOLESALE PRICE INDEX

The index numbers relate to the new series with base 1961-62 = 100. The new series include 139 commodities and 774 quotations.

The new series of the 'Wholesale price index: all commodities' contains seven major groups viz. food articles (413), liquor & tobacco (25), fuel, power, light & lubricants (61), industrial raw materials (121), machinery & transport equipment (79), chemical (7) and manufactured articles (294). The figures in brackets are the weights for the groups in a total of 1000.

The new series of 'Fuel, Power, Light & Lubricants' comprises coal (214), coke (57), kerosene oil (139), petrol (150), aviation spirit (17), diesel oil (123), lubricating oil (66), industrial alcohal (5), electricity (219) and castor oil (10).

'Iron & steel manufacture' cover items like structurals, plates & sheets, bars & rods, wires & hoops, galvanised corrogated sheets, tin plates, cast iron pipe, steel tubes and heavy rails.

## Wholesale Price Index

### All Commodities

| | (1961-62 = 100) |
|---|---|
| 1961-62 | 100.0 |
| 1962 | 104.1* |
| 1963 | 107.9 |
| 1964 | 119.1 |
| 1965 | 128.9 |
| 1966 | 144.3 |
| 1967 | 166.0 |
| 1968 | 165.3 |
| 1969 | 168.8 |
| 1970 | 179.2 |
| 1971 | 186.1 |
| 1972 | 191.4** |

## Fuel, Power, Light & Lubricants

### Wholesale Price Index

| | (Base 1961-62 = 100) |
|---|---|
| 1961-62 | 100.0 |
| 1962 | 102.1* |
| 1963 | 114.9 |
| 1964 | 119.7 |
| 1965 | 122.4 |
| 1966 | 132.5 |
| 1967 | 139.8 |
| 1968 | 147.2 |
| 1969 | 153.3 |
| 1970 | 160.4 |
| 1971 | 168.9 |
| 1972 | 175.5** |

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Source: Economic Adviser, Ministry of Industrial Development, Internal Trade and Company Affairs.

## Cement

### Wholesale Price Index

| | (Base 1961-62 = 100) |
|---|---|
| 1961-62 | 100.0 |
| 1962 | 103.5* |
| 1963 | 106.9 |
| 1964 | 109.8 |
| 1965 | 117.3 |
| 1966 | 135.1 |
| 1967 | 135.2 |
| 1968 | 135.6 |
| 1969 | 144.5 |
| 1970 | 149.1 |
| 1971 | 158.3 |
| 1972 | 162.7** |

## Iron & Steel Manufacture

### Wholesale Price Index

| | (Base 1961-62 = 100) |
|---|---|
| 1961-62 | 100.0 |
| 1962 | 105.4* |
| 1963 | 107.1 |
| 1964 | 111.1 |
| 1965 | 118.2 |
| 1966 | 124.9 |
| 1967 | 134.3 |
| 1968 | 142.2 |
| 1969 | 149.3 |
| 1970 | 161.2 |
| 1971 | 170.0 |
| 1972 | 183.4** |

---

* Figure relates to an average of nine months from April to December.

** Figure relates to an average of three months upto March.

## STORY OF

## AVERAGE EARNINGS OF FACTORY EMPLOYEES

The Statistics are collected under the Payment of Wages Act, 1936 and relate to factories defined under clause (m) of Section 2 of the Factories Act, 1948. This excludes workers in Railway Workshops but includes Defence Installations. The groups of industries of seasonal nature consisting of Food, Beverages, Tobacco and Gins & Presses are excluded. Earnings include basic wages, dearness allowance, overtime payment, other cash allowances including production or incentive bonus, efficiency bonus, money value of concessions, annual or profit bonus and arrears. The statistics are based on factories reporting and hence are subject largely to errors of varying non-response from year to year.

Prior to 1 April 1958, the Payment of Wages Act, 1936 applied to employees earning less than Rs.200 per month. With the enforcement of the Payment of Wages (Amendment) Act, 1957 with effect from 1 April, 1958, the scope of the Act was extended to cover persons earning Rs.200 or more but less than Rs.400 p.m. However, acceptable returns for these employees are received only with effect from 1961.

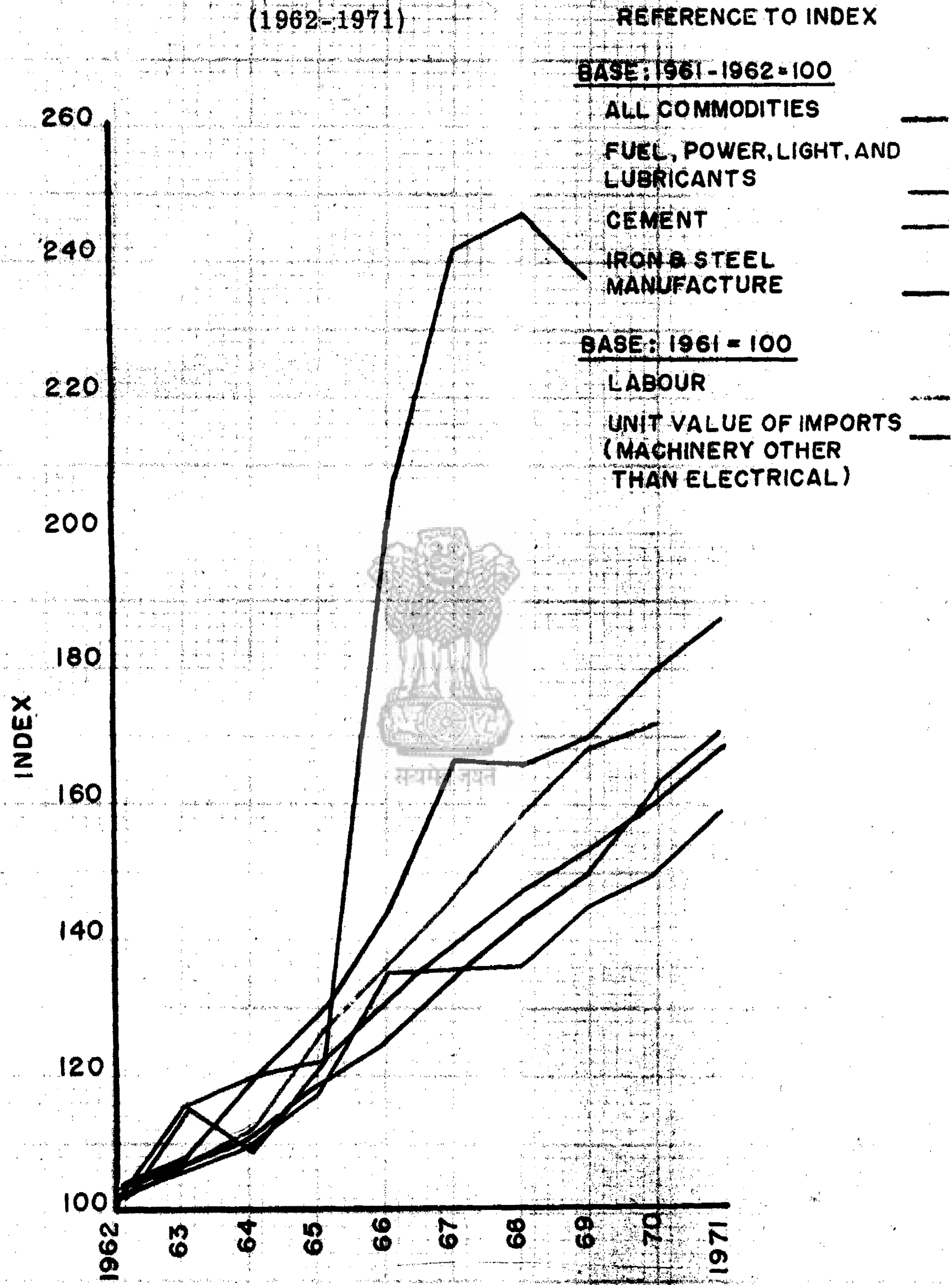
Average annual earnings of factory employees

| Year | Rs.per worker 1/ | Index No. (Base 1961 = 100) |
|---|---|---|
| 1961 | 1540 | 100 |
| 1962 | 1609 | 104 |
| 1963 | 1661 | 108 |
| 1964 | 1745 | 113 |
| 1965 | 1955 | 127 |
| 1966 | 2112 | 137 |
| 1967 | 2271 | 147 |
| 1968 | 2449 | 159 |
| 1969 | 2591 | 168 |
| 1970 | 2655 | 172 |

1/ Source: Labour Bureau, Ministry of Labour, Employment & Rehabilitation.

# BASIC STATISTICAL INDICATORS

(1962-1971)



# STORY OF

# INDEX OF UNIT VALUE OF IMPORTS

## (Machinery other than electrical)

The calssification of Indian Foreign Trade was revised in 1957 on the basis of the Standard international Trade Classification (SITC). This was called the Indian Trade Classification (ITC). Since the data for the first year 1957 was deficient in many ways, the year 1958 was chosen as the base. The index covers 84 per cent of the total value of all imports. Aggregate number of articles covered in the general index is 511.

The index was calculated by comparing the trade in the current period with that revalued at 1958 prices. Many items could not be included because information on quantities were not available in precise form. Adjustments were made on the assumption that the price changes in the items not covered in a section were similar to those shown by the items included in the calculation.

Index of unit value of imports: Machinery other than electrical

| Year | Index No. [1/] (1958 = 100) | Index No. (1961 = 100) |
|---|---|---|
| 1958 | 100 | |
| 1959 | 91 | |
| 1960 | 103 | |
| 1961 | 107 | 100 |
| 1962 | 107 | 100 |
| 1963 | 123 | 115 |
| 1964 | 117 | 109 |
| 1965 | 130 | 122 |
| 1966 | 218 | 204 |
| 1967 | 259 | 242 |
| 1968 | 264 | 247 |
| 1969 | 254 | 237 |

1/ Source: Director General of Commercial Intelligence & Statistics, Ministry of Foreign Trade.

Appendix 6

## CONSTRUCTION COST INDEX

Cost indices have been constructed for the following major items of work which form bulk of the cost of a river valley project.

i) Earthwork by machinery
ii) Earthwork by manual labour
iii) Reinforced cement concrete
iv) Stone masonry

The methodology adopted in working out these indices has been explained in brief in this appendix.

In order that the construction cost index for any item of work may be prepared, it is necessary to have the index for the prices of the basic materials and wages of labour which form the cost elements of an item of work. The basic elements considered for the four items of work mentioned above are cement, steel, fuel, labour and machinery.

The wholesale price index of cement is available from the Economic Adviser, Ministry of Industrial Development's publication on Index Numbers of Wholesale Prices in India with base 1961-62 = 100. This has been utilised. The same publication gives price indices of 'iron and steel. manufacture', 'fuel, power, light and lubricants', 'machinery and transport equipment' but the series are not found quite relevant to the concerned work.

The price index of iron and steel manufacture given in the above publication includes corrugated iron sheets, tin plates, cast iron pipes, etc. While for the item of reinforced cement concrete, the steel would be required more in the shape of rods and bars. The Planning Commission's Report on Economies in Construction Costs, March 1968, gives the price index of mild steel bars with base 1949 = 100 which has been taken after suitable modification and extension.

The index for 'fuel, power, light & lubricants' apparently cover all types of consumptions including domestic and is heavily weighted with coal & coke, kerosene and petrol. Diesel oil and lubricating oils which are required for use in construction form a weight of only 189 out of 1000. As such, instead of utilising this index, the series given separately for diesel oil and lubricating oil have been blended for use in the preparation of the construction cost index.

The machinery used in the construction of river valley projects are mostly imported items for which reason the official series for 'Machinery and Transport Equipment' do not suit. There is also the index showing the price rise of imported equipment available from the Ministry of Foreign Trade. This, however, gives the index of unit value of imports. The index does not furnish any useful information as one unit is not comparable with another unit unless both are of similar capacity. As such, this index also could not be utilised. As there was no official index available in proper form for use in preparing the construction index, the series had to be built up after collecting whatever information was available with an importing firm for the type of machinery used in the construction work.

No reliable series are available which can give an indication of the increase in labour cost in irrigation and multipurpose projects. The official series available from the Labour Bureau, Ministry of Labour, Employment & Rehabilitation are of average annual earnings of factory employees'. The labour employed in the construction of river valley projects are of casual nature and the rise in labour wages in this sector during the last 10 years has been very steep. The index for factory employees does not reflect the trend of labour wages in the construction sector. Recourse was, therefore, taken to the information furnished by the projects about the daily wages paid to the different categories of labour over the past six years and the index built with suitable extensions.

The price indices built up for adoption may be seen from the following statements.

## Cement

### Wholesale Price Index

(Base 1961-62 = 100)

| | |
|---|---|
| 1961 - 62 | 100 |
| 1962 | 104 |
| 1963 | 107 |
| 1964 | 110 |
| 1965 | 117 |
| 1966 | 135 |
| 1967 | 135 |
| 1968 | 136 |
| 1969 | 145 |
| 1970 | 149 |
| 1971 | 158 |
| 1972 (till March) | 163 |

Source : Economic Adviser, Ministry of Industrial Development, Internal Trade and Company Affairs.

## Steel

(Mild steel bars)

### Wholesale Price Index

(Base 1961-62 = 100)

| | |
|---|---|
| 1961 - 62 | 100 |
| 1962 | 100 |
| 1963 | 105 |
| 1964 | 106 |

| | |
|---|---|
| 1965 | 109 |
| 1966 | 116 |
| 1967 | 125 |
| 1968 | 131 |
| 1969 | 138 |
| 1970 | 145 |
| 1971 | 155 |
| 1972 (till March) | 165 |

Source: Report on Economies in Construction Costs, Planning Commission, March 1968.

Further coverage: For the period beyond 1968 the prices of steel bars announced by the Joint Plant Committee have been collected and utilised in building up the index.

## Fuel & Lubricants

(Wholesale price index)

(Base 1961-62 = 100)

| | |
|---|---|
| 1961 - 62 | 100 |
| 1962 | 100 |
| 1963 | 119 |
| 1964 | 124 |
| 1965 | 115 |
| 1966 | 115 |
| 1967 | 119 |
| 1968 | 122 |
| 1969 | 124 |
| 1970 | 125 |
| 1971 | 130 |
| 1972 (till March) | 132 |

Source: The index nos. of diesel and lubricating oils available from individual series of each published by the Economic Adviser, Ministry of Industrial Development, Internal Trade and Company Affairs.

Construction of Index: The combined index of "Fuel and lubricants" has been constructed by blending 5 weights of diesel and one weight of lubricating oil.

# Labour

## Index for daily wages

(Base 1961-62 = 100)

| Year | Labour Unskilled | Labour Mechanised Work | Labour Masonry Work |
|---|---|---|---|
| 1961 - 62 | 100 | 100 | 100 |
| 1962 | 100 | 105 | 101 |
| 1963 | 100 | 105 | 101 |
| 1964 | 107 | 108 | 107 |
| 1965 | 120 | 123 | 120 |
| 1966 | 120 | 169 | 125 |
| 1967 | 135 | 171 | 137 |
| 1968 | 200 | 180 | 199 |
| 1969 | 217 | 191 | 217 |
| 1970 | 217 | 194 | 217 |
| 1971 | 223 | 224 | 227 |
| 1972 (till March) | 223 | 224 | 227 |

Source:

1. Daily wages of different categories of labour for the years 1965 to 1971 available from the major irrigation projects under construction.

2. Yearly average earnings of factory employees for the years 1961-65 available in "Basic Statistics Relating to the Indian Economy, 1950-51 to 1969-70, Planning Commission, Dec., 1970".

Construction of Index:

1. The wages of construction labour for the years 1961 to 1964 have been worked back from 1965 in proportion to the annual earnings of the factory employees, in the absence of any other data being available.

2. The combined labour index for mechanised work has been constructed by adopting the weights of operator: helper: foreman: other labour as 15:15:2:5.

3. The combined labour index for masonry work has been built up by taking the weights of 1 mason and 4 unskilled labour.

## Imported Construction Machinery

## Price Index

(Base 1961-62 = 100)

| | |
|---|---|
| 1961 - 62 | 100 |
| 1962 | 100 |
| 1963 | 103 |
| 1964 | 107 |
| 1965 | 112 |
| 1966 | 119 |
| 1967 | 197 |
| 1968 | 205 |
| 1969 | 216 |
| 1970 | 226 |
| 1971 | 237 |
| 1972 (till March) | 248 |

Source: Ex. factory price in U.S. Dollars of construction equipment like tractors, scrapers, dumpers, etc. collected from an importing firm.

Construction of Index: The ex-factory prices have been converted into Indian rupees which takes into account the effect of devaluation of the Indian rupee in 1966. The index has been built up from these prices.

Drawbacks: No statistics regarding prices f.o.b., c.i.f. or sale price in India inclusive of duties levied by Govt. is available. In case the freight, insurance, duties, etc. have risen in the same proportion as the ex-factory prices, the index would not be affected. Otherwise, the index will be erroneous to the extent these charges have deviated from the proportionate cost. Notwithstanding this drawback, the index will indicate a more correct trend of cost escalation of the prices of imported machinery than the only official index available for unit value of imports for machinery.

## Cost index for earthwork by machinery

Now, coming to the construction cost index of the work items, it may be mentioned that to represent 'earthwork by machinery' the work considered is the excavation and transport of earth by the most commonly used combination of equipments viz. shovel and dumpers with a tractor to help. The lead involved has been assumed as one mile.

The quantum of each element viz., depreciation, fuel and labour has been assessed from the usual rate analysis of earthwork with this machinery combination inclusive of the repairs and maintenance necessary for the earthmoving equipment. The cost structure of the work item i.e. the cost of each element and the percentage thereof to the total cost is then worked out with 1961-62 prices. The percentage costs of the elements form the weights from which the consolidated index for the item of work is constructed.

For earthwork by machinery described above, the weights have been worked out as -

machinery (i.e. depreciation) - 67

fuel ... ... - 17

labour ... ... - 16

The cost index for earthwork by machinery prepared on the basis of the above weights may be seen from the statement enclosed.

## Cost index for reinforced cement concrete

The construction cost index of reinforced cement concrete has been based on the cost indices of five basic elements viz., cement, steel, labour, machinery and fuel. To consider a representative mix of concrete for a dam and its appurtenant works, one unit (i.e. a hundred cft.) of the item has been assumed to contain 1760 lbs. of cement and 350 lbs. of steel besides 100 cft. of stone metal and 50 cft. of sand.

Sand is available from river bed and assumed to be excavated wholly by manual labour. The stone for aggregate is obtained by drilling & blasting rock quarries and collecting and crushing them mechanically. The lead involved in the transport of sand has been taken as one mile and that for stone as two miles.

The basic elements of cost like depreciation (machinery), labour, cement, steel, 'fuel & miscellaneous' have been segregated from each operation like manufacture of aggregate including drilling, blasting, mucking, crushing and transport; sand excavation including transport; steel including bending, binding and placing; and mechanical mixing and laying of concrete. Miscellaneous requirements cover gelatine, detonators, etc. which have been clubbed with fuel and their price increase considered to be same as of fuel. The weights of different elements have now been found in the same manner as explained for earthwork above. And from these weights, the consolidated index for the item of work is constructed. For reinforced cement concrete described above, the weights have been worked out as -

cement - 25
steel - 30
machinery - 20
fuel & misc. - 8
labour - 17

The cost index for reinforced cement concrete prepared on the basis of the above weights may be seen from the statement enclosed.

## Cost index for stone masonry

The construction cost index of stone masonry has been prepared for random rubble masonry in cement mortar in the ratio of 1:5. The lead of stone has been assumed as two miles and that of sand one. Transport of materials has been assumed by trucks and the entire masonry work by manual labour except mixing of mortar and lifting of materials which are mechanised.

As in case of concrete, the basic elements viz. labour, depreciation (i.e. machinery), cement and 'fuel & miscellaneous' have been separated from each operation like excavation of stone including drilling, blasting and collection; excavation of sand; transport of stone and sand; lifting of materials and laying of masonry including mixing mortar. As explained in case of earthwork and concrete, the percentage costs of the different elements in the total cost of the item of work have now been found. These are the weights from which the consolidated index for masonry is constructed.

For the stone masonry described above, the weights have been worked out as -

labour - 42
machinery - 17
cement - 30
fuel & misc. - 11

The cost index for stone masonry prepared on the basis of the above weights may be seen from the statement enclosed.

## Cost index of earthwork by manual labour

For earthwork by manual labour, the index for daily wages of unskilled labour itself has been taken to represent the construction cost index.

## Cost Index for Earthwork by Machinery

| | Weight | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1961-62 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 (till March) |
| Labour | 16 | 100 | 105 | 105 | 108 | 123 | 169 | 171 | 180 | 191 | 194 | 224 | 224 |
| Machinery | 67 | 100 | 100 | 103 | 107 | 112 | 119 | 197 | 205 | 216 | 226 | 237 | 248 |
| Fuel | 17 | 100 | 100 | 119 | 124 | 115 | 115 | 119 | 122 | 124 | 125 | 130 | 132 |
| Earthwork £/ | 100 | 100 | 101 | 106 | 110 | 114 | 126 | 180 | 187 | 196 | 204 | 217 | 225 |

£/ Formula used to work out the composite index for earthwork is $w1r1 + w2r2 + w3r3/w1 + w2 + w3$ where w1, w2 & w3 are the weights of labour, machinery & fuel and r1, r2 & r3 are the indices for labour, machinery & fuel.

## Cost Index for Reinforced Cement Concrete

| | Weight | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1961-62 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 (till March ) |
| Labour | 17 | 100 | 105 | 105 | 108 | 123 | 169 | 171 | 180 | 191 | 194 | 224 | 224 |
| Machinery | 20 | 100 | 100 | 103 | 107 | 112 | 119 | 197 | 205 | 216 | 226 | 237 | 248 |
| Cement | 25 | 100 | 104 | 107 | 110 | 117 | 135 | 135 | 136 | 145 | 149 | 158 | 163 |
| Steel | 30 | 100 | 100 | 105 | 106 | 109 | 116 | 125 | 131 | 138 | 145 | 155 | 165 |
| Fuel | 8 | 100 | 100 | 119 | 124 | 115 | 115 | 119 | 122 | 124 | 125 | 130 | 132 |
| Reinforced Cement Concrete | £/ 100 | 100 | 102 | 106 | 109 | 114 | 130 | 149 | 155 | 164 | 169 | 182 | 188 |

£/ Formula used to work out the composite index for reinforced cement concrete is w1r1 + w2r2 + w3r3 + w4r4 + w5r5 / w1 + w2 + w3 + w4 + w5 Where w1, w2, w3, w4 & w5 are the weights of labour, machinery, cement, steel & fuel and r1, r2, r3, r4 & r5 are the indices of labour, machinery, cement, steel & fuel.

## Cost Index for Stone Masonry

| | Weight | Indices | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1961-62 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 (till March) |
| Labour | 42 | 100 | 101 | 101 | 107 | 120 | 125 | 137 | 199 | 217 | 217 | 227 | 227 |
| Machinery | 17 | 100 | 100 | 103 | 107 | 112 | 119 | 197 | 205 | 216 | 226 | 237 | 248 |
| Cement | 30 | 100 | 104 | 107 | 110 | 117 | 135 | 135 | 136 | 145 | 149 | 158 | 163 |
| Fuel | 11 | 100 | 100 | 119 | 124 | 115 | 115 | 119 | 122 | 124 | 125 | 130 | 132 |
| Stone Masonry £/ | 100 | 100 | 102 | 105 | 110 | 117 | 126 | 145 | 173 | 185 | 188 | 197 | 201 |

£/ Formula used to work out the composite index for masonry is w1r1 + w2r2 + w3r3 + w4r4 / w1 + w2 + w3 + w4 where w1, w2, w3 & w4 are the weights of labour, machinery, cement & fuel and r1, r2, r3 & r4 are the indices for labour, machinery, cement & fuel.

Appendix 7

# GUIDELINES FOR INVESTIGATIONS OF MAJOR IRRIGATION AND HYDRO-ELECTRIC PROJECTS

No.23/35/71 - TE
Government of India
Central Water and Power Commission
(Water Wing)

New Delhi, the February, 1972

To

The Secretary to the Govt. of
____________________________
____________________________

Subject: Irrigation and multipurpose projects - formulation and submission of.

Sir,

The procedure for the formulation, submission and examination of irrigation and multipurpose projects has been laid down by the Planning Commission in their circulars to the State Governments from time to time. The project reports are received in the Central Water & Power Commission for technical scrutiny and establishing their feasibility before their acceptance by the Planning Commission. It has been our experience that in many cases, the project reports are not based upon adequate and reliable data and do not contain all the desired information. This results in frequent exchange of correspondence with the States and consequent delay in the clearance of the project. This delay can be avoided if the following points are strictly followed by the States in formulating and submitting the projects to C.W.& P.C.

1) The project reports are prepared after detailed topographical and geological investigations and collection of sufficient data for establishing hydrology of the scheme. The guidelines for investigations of irrigation and hydro-electric projects, have been formulated in C.W.& P.C. and a copy is enclosed for reference.

2) The projects are planned for the optimum utilisation of water for the best benefits of the region. The inter-linking of the project with other existing projects and further stages of development should be considered in details in the project report. The detailed studies for the alternative proposals considered, should be incorporated in the project reports, spelling out the costs, merits and demerits of each.

3) Water utilisation, ayacut development plans, the soil characteristics, regional climate and rainfall and consequential cropping pattern and the adverse effect of irrigation in the command, if any, should be considered in details in the project report. Union Ministry of Agriculture, Department of Agriculture (Water Management Division) has brought out technical series Nos. 1 to 4 regarding soil characteristics, irrigation water requirements, etc. These should be referred to.

4) The conjunctive use of ground water with surface and rainwater to achieve economy in water utilisation and give benefits to wider areas, should be critically analysed and spelled out. The conjunctive use of surface water and ground water could be a big fillip to irrigated agriculture and should be considered in detail.

5) Planning for construction plant and equipment should be done at the project report stage itself. The requirement of foreign exchange, if any, should be clearly spelled out. The construction planning should be based on the expected delivery of the plant and equipment from foreign and indigenous sources.

6) Some of the projects involve interstate aspects and the concurrence of one or more States is required before they can be processed by C.W.& P.C. In several cases, no efforts are made by the State formulating the project to reach an agreement with the other concerned States. In cases where requests are made to C.W.& P.C. for resolving such disputes, the discussions are arranged between the concerned States and it is our experience that even after prolonged discussions sometimes the disputes are not

resolved. Such delays result in increase in the cost of the project and ultimately when the disputes are resolved, they undergo major changes in the project planning. The labour involved in the examination of the project during this period, therefore, becomes infructuous. It would be desirable if efforts are made by the States to reach an agreement with other concerned States regarding the sharing of water, etc. before the projects are formulated. In case, help from the C.W.& P.C. is required for resolving such disputes, this may be sought at the formulation stage itself before the projects are submitted to C.W.& P.C.

7) The procedure for the submission of the project reports to C.W.& P.C. has been laid down by the planning Commission in their circulars to the States from time to time. This should be strictly adhered to. The project report for the schemes costing between Rs.25 lakhs and Rs. 5 crores should be in the prescribed proforma with detailed replies against each item of the proforma. The project reports for the schemes costing more than Rs.5 crores should have the prescribed check-list attached to them with detailed replies against each item.

8) The project reports prepared by the State Departments or Electricity Boards should be examined by the concerned Department of the State Government first and only the reports accepted by them should be forwarded by the State Governments to the C.W.& P.C. for examination. The concurrence of the following Departments of the State Governments should also be attached when the project reports are forwarded to C.W.& P.C.:-

| | | | |
|---|---|---|---|
| i) | Revenue Deptt. | - | For the rates of land acquisition, compensation for land, houses and other properties and the amount for rehabilitation, etc. |
| ii ) | Finance Deptt. | - | Specially in respect of the unproductive schemes and for financial return calculations, etc. |
| iii) | Agriculture Deptt. | - | Cropping pattern, effective rainfall, delta and duty in the field, soil survey report, salinity, drainage, ground water levels, water-logging and conjunctive use of ground and surface waters, etc. |
| iv) | Statistics Deptt. | | Rates of produce during previous 5 years, B.C. Ratios, etc. |

9) Sufficient number of copies of the project Report should be forwarded to C.W.& P.C. to enable simultaneous examination in various specialised Directorates of the Commission and also in the Ministry of Finance and Ministry of Agriculture. The number of project reports so required to be sent was laid down in C.W. & P.C.'s letter No.4/10/63-TE, dated 5.7.63 addressed to all State Governments and is reproduced below:-

i) Irrigation Project Reports - 11 copies

ii) Multipurpose project reports
(irrigation & hydro-power) - 15 copies

iii) Multipurpose project reports
(irrigation, hydro-power and flood control) - 17 copies

iv) Multipurpose project reports
(irrigation and flood control) - 13 copies

v) Hydro-electric project reports - 10 copies

vi) Rural Electrification schemes - 5 copies

vii) Power & Flood control schemes - 6 copies

For the Proforma Reports, for the schemes costing between Rs. 25 lakhs and Rs. 5 crores, six copies may be sent.

If the aforesaid points are strictly followed by the State while formulating and submitting the schemes, it would considerably help in expediting the examination of the project in C.W. & P.C. After the schemes are examined in C.W. & P.C., the comments are sent to the States for replies, further clarifications and submission of additional information. In several cases it has been noticed that the replies from the State Governments have not been received for years together and the projects are considered pending with C.W. & P.C. It has been decided that in cases where replies are unduly delayed and ordinarily not received from the State within a period of one year, the project report will be deemed to have been withdrawn by them. The project will be considered afresh by the Central Water and Power Commission on receipt of fresh Reports.

I hope the suggestions above would receive urgent consideration of the State Governments.

Yours faithfully,

Sd/- S.K. JAIN
11.2.72

Encls: as above.

Chairman
Central Water and Power Commission

GOVERNMENT OF INDIA
CENTRAL WATER AND POWER COMMISSION
(WATER WING)

# GUIDE LINES FOR INVESTIGATIONS OF MAJOR IRRIGATION AND HYDRO-ELECTRIC PROJECT

NEW DELHI
JANUARY, 1972

सत्यमेव जयते

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# APPENDICES

Appendix I Map of India showing the principal lithological groups.

Appendix II Seismic zones of India.

Appendix III Seismic co-efficients for some important towns.

Appendix IV Composition of Inter-disciplinary official body.

Appendix V Map of India showing the annual normal rainfall.

Appendix VI Soil Map of India.

Note: The maps at Appendices I, II, V and VI have not been enclosed with this report.

सत्यमेव जयते

# GUIDELINES FOR INVESTIGATIONS OF MAJOR IRRIGATION AND HYDRO-ELECTRIC PROJECT

In order to ensure preparation of sound and economical projects, it is necessary to have thorough and systematic investigations. The investigations should include the study of various alternatives regarding the layout of the scheme as a whole and also details of alternatives considered for the type and location of various features of the project. The final alternative recommended should be fully justified recording the reasons for its choice as against the others. The minimum surveys and investigations necessary for the purpose are of the following nine types:

1. Topographical Surveys.
2. Geological and Foundation Investigations.
3. Hydrological and Meteorological studies.
4. Pre-Irrigation soil survey and drainage.
5. Special surveys for hydro-electric projects.
6. Construction materials investigations.
7. Communication materials investigations.
8. Collection of relevant data for drawing out programme of construction including coffer dam construction.
9. Hydraulic model studies for setting the important features of the project.

General and broad requirements with regard to each of the above type of investigations are set- forth hereunder:

## 1. TOPOGRAPHICAL SURVEYS

1.1 Surveys for preparation of plans should be carried out of the area covering the dam site, the reservoir area and other project features. Property surveys should be done for the reservoir area. Adequate number of G.T.S. Bench marks should be got established by the Survey of India.

1.2 Survey plans of the project will be prepared and exhibited to cater for requirements as indicated below:

(i) The dam site topographical survey plans should cover an area sufficient to accommodate to all possible arrangements of the projects (dam, spillway, outlet works, diversion works etc.). For a large structure, a scale of 1/1000 with contours at intervals of 2m. would be adequate. Unless otherwise necessary, the plan will cover an area at least upto about 200 m. upstream and 400 m. downstream of the dam site and extend well beyond the abutments.

(ii) The reservoir submergence plans may be prepared to scale of 1/15000 with contours at intervals of 2 m to 3 m depending upon the size of the reservoir. Area capacity curves and tables will be prepared to an elevation high enough to allow for the anticipated maximum reservoir level.

(iii) The command area survey plans may be to a scale of 1/15000 with contour intervals of 0.5 m.

(iv) For a barrage structure, detailed survay maps will cover the area under the barrage and appurtenant works (guide banks) head regulators road and rail approaches, site for colony etc. The plan may be to a scale of 1/4000 with levels in a 30 m. grid.

(v) River surveys in a length of about 10 km. upstream and 10 km. downstream and one diversion structure will be carried out. On the basis of this survey, an L-Section of the river will be prepared. Cross-Sections will be taken 300 m apart, extending sufficiently above the H.F.L.

(vi) Along the canals alignment, L-Section should be prepared with levels at 50 m. intervals and Cross-Sections 100 m apart extending to 100 m on either side of the centre lines of the canal. The longitudinal sections should show the soils that will be met with in the canal excavation.

(vii) Surveys connected with cross-drainage works should include L-Section and Cross-Sections of the drains, along with details of catchment areas, high flood discharges, observed H.F.L. along with canal data at the point of crossing.

(viii) For the location of power station, the survey plan should cover an area sufficient to include alternative station layouts and should give contours at intervals of 5 m. Low Water level, maximum observed flood level rock out crops, sand shoals, etc. where the plant is to be on the bank of the river, will be indicated therein.

(ix) L-Sections covering power channels, penstocks and tailrace channels should be prepared. The L-Section should give at levels 50 m. intervals and should show log of boreholes at points recommended by the Geologist of Geological Survey of India. Cross-Sections should also be taken at 100 m. intervals extending sufficiently on both sides.

(x) For tunnels, longitudinal sections along tunnel alignment and contour plan with 50 m intervals covering about 100 m on either side of the alignment and also upto contours corresponding to tunnel grade, if applicable, indicating location of adits.

(xi) For surge tank contour plan of surge tank area at 5 m contour intervals.

(xii) For underground power house, contour plan at 1 in 4000 showing contour intervals at 15 m covering location of access tunnels, tailrace tunnel, switchyard.

## 2. GEOLOGICAL AND FOUNDATION INVESTIGATIONS

2.1 A resume should be prepared for the regional geology. Geological sections to show known and interpreted sub-surface conditions should be prepared. A geological map appended to this note gives the general pattern of geological strata met with in various places of the country (Appendix I).

2.2 Seismic conditions of the region should be investigated with reference to the geological map of the vicinity. For the purpose of determining the seismic co-efficients the country is divided into five zones as given in the map (Appendix II).

2.2.1 Unless otherwise stated, horizontal seismic coefficient for static design in different zones shall be taken as follows (see 2.2.3).

| Zone No. | Horizontal Seismic Coefficient |
|---|---|
| V | 0.08 |
| IV | 0.05 |
| III | 0.04 |
| II | 0.02 |
| I | 0.01 |

For detailed design practice, please refer to I.S. Code No.4326 of 1967 and its subsequent amendments BDC(38) (1968) which is under print.

## VALUES OF B.F.R. DIFFERENT SOIL FOUNDATION SYSTEM

| Sl. No. | Type of soil Mainly constituting the foundation | Value of for | | | |
|---|---|---|---|---|---|
| | | Bearing Piles resting on soil Type I or Raft Foundation | Friction Piles, Combined or Isolated RCC footings with tie beams | Isolated Footings without the Beams or Unreinforced strip foundations | Well foundation |
| 1 | 2 | 3 | 4 | 5 | 6 |
| (i) | Type I Rock or Hard Soils | 1.0 | 1.0 | 1.0 | 1.0 |
| (ii) | Type II Medium Soils | 1.0 | 1.0 | 1.2 | 1.2 |
| (iii) | Type III Soft Soils | 1.0 | 1.2 | 1.5 | 1.5 |

2.2.2 The seismic coefficients according to 2.2.1 for some important towns and cities are given in appendix III.

2.2.3 Buildings provided for accommodating essential services which will be of post earthquake importance, such as hospitals, emergency relief stores, foodgrain storage structures, waterworks, water towers and power stations shall be designed for one and half times the seismic coefficient given in 2.2.1 or one and half times the F-values specified in Appendix of Revised I.S.I. Code of Practice for Earthquake Resistance Construction of Building.

2.2.4 The vertical seismic coefficient where applicable may be taken as half of the horizontal seismic coefficient as indicated in 2.2.1.

The design seismic co-efficient should be got confirmed from the standing committee set up for the purpose by the Ministry of Irrigation and Power and composition of the Committee is enclosed in Appendix IX.

## 2.3 FIELD TEST

Evaluation of seismic status of faults and thrusts and collection and maintenance of seismological data both in pre-construction as well as post construction stages of river valley projects are of vital importance because of safety reasons. Recommendations given in I.S.I. Code No. 4967-1968 for seismic instrumentation for River Valley Projects may be used for investigation of seismicity of site for any project besides river valley projects, if the situation and the magnitude of the project justifies so.

2.4 Geological investigations should be carried out for determining the water tightness of the proposed reservoir, present or otherwise of solution channels, sink holes, etc. and the existing and potential slide areas. The survey should also include an assessment of valuable mineral deposits in the reservoir and existing and potential slide areas.

2.5 Foundation investigations for earth/rockfill/masonry concrete dams and other structures may be as under:

### 2.5.1 EARTH AND ROCKFILL DAMS

i) Bore holes at a minimum spacing of 150 m all along the dam alignment should be drilled to a depth equal to the height of the dam at the location of the hole or 5 m below bedrock whichever is more. The method of drilling adopted should be specified. Bore holes logs for soil strata must be in accordance with I.S.I. Unified classification system.

ii) In situ permeability tests in all the bore holes should be carried out at various depths of hole.

iii) For cohesive materials, at least one undisturbed sample for each soil stratum met with shall be tested for in-situ density and natural moisture content as well as for shear parameters in triaxial shear with pore pressure measurements under saturated condition. Degree of compaction of the foundation material in terms of Proctor density for the material in each stratum will be determined.

iv) Where the foundation material is cohesionless the relative density of material will be determined at various depths, extending upto a depth equal to the height of the dam or to rock whichever is higher.

### 2.5.2 MASONRY/CONCRETE DAMS

i) Exploratory holes and/or drifts should cover the entire foundation and abutment area of the dam including energy dissipation structure. The location, spacing and depth of holes shall be decided in consultation with an engineering geologist of the Geological Survey of India.

ii) Description and logs of exploration should include ground elevation at the hole, location coordinates and sufficiently detailed remarks regarding the nature and type of rocks, geological structure, water loss etc. for a clear interpretation of the foundation conditions.

iii) Contour of bed rock and geological structure of foundation strata should be presented.

iv) Location and thickness of weathered, altered or otherwise softened zones and their characteristics and the structural weaknesses and discontinuities shall be investigated.

v) Tests for significant engineering properties of foundation rock such as density, absorption, permeability, shear compressive strength and strain characteristic (including the effect of moisture content) should be done and data presented. Where the type and/or structure of rock is such that its competency to ensure the stability of the dam against a sliding failure is in doubt, necessary in-situ shear tests should be done and data presented.

### 2.5.3 BARRAGES/WEIRS

i) Along the proposed alignment of the barrage, exploratory holes spaced 150 m apart should be put to determine soil profile upto a depth of 30 m below average bed level on permeable strata. Where sheet rock is met earlier, the depth of drill holes may be taken 3 m in rock.

ii) Samples of soil obtained from bore holes should be tested for properties as set forth under items 6.4.2.

### 2.5.4 WATER CONDUCTOR SYSTEM

i) The L-section of the water conductor system from intake structure to tail-race should be given. In power channel portion, trial pits to adequate depth be put in at suitable intervals so as to indicate all changes of strata.

ii) For tunnel a geological section of the tunnel alignment and surge shaft and drill holes adequate to establish cover of rock and important geological features, should be given.

### 2.5.5 POWER STATIONS

i) 2 to 4 drill hole details for the power station area may be given. The number, location, spacing and depth shall be decided in consultation with an Engineering Geologist of the Geological Survey of India.

ii) The Survey Plan should cover an area sufficient to include switchyard and alternative plant lay-outs and should give contours at intervals of 5 m. Lower water level maximum observed flood level, rock out crops, sand shoals etc. at the power house site will be indicated therein.

iii) Indications of slides and their locations and the possibility of rock falls in the hill slopes should be explored.

iv) Ground water level at the plant site should be determined.

v) For under ground power house, a geological section of power house, pressure tunnel, access tunnels and switchyard and sufficient drill holes/drifts to establish the geological features of the same.

### 2.5.6 CANALS AND CANAL STRUCTURES

i) On the canal alignment test pit or auger hole data should be collected at about 500 m intervals and results thereof indicated in the L-section.

ii) Test pit or bore hole data should be collected for each drainage crossing for deciding the nature of foundations of structure.

## 3. METEOROLOGICAL AND HYDROLOGICAL STUDIES

3.1 On the water shed plan should be shown (a) the prominent orographic features (b) normal annual isohyets (c) location of raingauge stations in and around the catchment (the source of rainfall data should be indicated (d) gauge and discharge sites and (e) inter-state boundaries. A map of India showing Annual Normal Rainfall is enclosed as Appendix V.

3.2 The weighted catchment rainfall should be assessed.

3.3 Data and frequencies of heavy rainfall in catchment and its neighbourhood should be collected and evaluated. Standard project storm or maximum probable storm rainfall depths including maximisation should be determined.

3.4 Climatic investigation for the project command should include Pan-Evaporation data where available. If, however, this is not available, information on the following items may be collected.

1. Mean latitude and longitude of the command.
2. Mean elevation.
3. Mean monthly rainfall for ten separate years, if possible.
4. Mean monthly temperature. Maximum and minimum monthly temperatures and maximum variation in daily temperatures for each month should be observed.
5. Wind velocity in km./hr.
6. Relative humidity percentage
7. Percentage or cloud cover

(Monthwise average)

3.5 Gauge and discharge observations (preferably by current meter) should extend for at least five years at the project site. Observed data for as many years as possible, should be collected for the nearest site on the same stream or for adjoining stream(s) with similar catchment characteristics.

3.6 Sediment observations should be carried out for a period of three years of the suspended load, bed load and natural soil conditions including catchment characteristics from the point of erosion. The silt manual by C.S.M. Research Station of C.W. & P.C. may be referred to for further details.

3.6.1 Chemical and petrographic analysis of river water may be examined and report maintained.

3.7 Gauges and discharges during flood occurrence should be observed at short intervals say hourly and survey map of floor marks of past floods.

3.8 The following hydrological studies are required:

i) Rainfall run-off correlation studies.

ii) Estimation of annual yields and their break-up into monthly, monsoon and non-monsoon run-off.

iii) Actual 10-daily observed run-off pattern for run-off the river projects.

iv) Estimate yields for reliabilities of 75%, 90% and 100% for irrigation, power and water supply projects respectively.

v) Working tables for a representative cycle of years to ascertain the percentage success of the project.

vi) Observed river hydrographs.

vii) The criteria to be followed in the estimation of design flood for major and medium dams and other hydraulic structure, are as follows:

### 3.8.1 IN THE CASE OF MAJOR AND MEDIUM DAMS

3.8.1.1 In the design of spillway for major and medium projects (with storages more than 50,000 acre ft.) the maximum probable flood which is the maximum flood for which there is a reasonable chance of occurring at the site should be used. The method of estimation of the maximum probable flood is the one using the unit hydrograph principle and the maximum probable storm. The maximum probable storm is an estimate of the physical upper limit to storm rainfall over a basin. It is obtained from storm studies of all the storm that have occurred in the region and maximising them for the mechanical efficiency of the storm in changing water vapour and droplots in the atmosphere into rain and moisture content of the rain-producing air mass involved in the storms. It has been the practice till now not to attempt maximisation for mechanical efficiency of the storm due to insufficient knowledge of this factor; therefore for the present maximisation for moisture content need only be made.

3.8.1.2 The distribution of storm intensities for small durations is obtained on the basis of recorded date of self-recording rain guage stations in the concerned catchment or region. The range of maximisation of unit hydrograph peak should be taken between 0 to 50 percent based on the discretion and judgement of the hydrologist. If the unit hydrograph is derived from very heavy floods of considerable volumes then the increase need be of a small order. But if it is derived from low floods then the increase has to be substantial.

The rate of infiltration loss should be estimated from the volume of flood run-off and the corresponding storm rainfall that caused that flood etc. and a minimum infiltration rate has to be adopted.

3.8.1.3 The probability method when applied to derive design floods for long recurrence intervals several times larger than the length of data has many limitations. In certain cases, however, like that of very large catchments where unit hydrograph method is not applicable and where sufficient long term discharge data is available, the frequency method may be only course possible. In such cases the design flood to be adopted for major structures should have a frequency of not less than once in 1,000 years. Where annual flood values of adequate length are available, they are to be analysed by the Gumbel's method and where the data is short either partial duration method or regional frequency technique is to be adopted as a tentative approach and the results verified and checked by hydro-logical approaches.

Sometimes when the flood data is inadequate, frequency analysis of recorded storms is made and the storms of a particular frequency applied to the unit hydrograph to derive the flood; this flood usually has a return period greater than that of the storm.

3.8.1.4 While planning there may be some projects where there is hardly any discharge data available. In such circumstances for preliminary studies the peak flood may be estimated by empirical formulae. The empirical formula commonly used in Central and Northern India is the Dicken's formula $Q = CA^{3/4}$ where A is the catchment area in sq. miles and C is a constant. The constant C varies widely; and it is subject to individual judgement its value is of the order of 200 to 400 for plain catchment and 1000 to 2000 in the mountaineous region according to catchment characteristics. In South India, Ryv's formula $Q = CA^{2/3}$ is adopted, the value of C being 450 in flat tracts along coast and it varies widely, being of the order of 2,800 in the Western Ghat region. In Maharashtra, Inglis' formula

$$Q = \frac{7000\ A}{\sqrt{A+4}} \quad \text{and} \quad Q = \sqrt{7000\ A} \qquad \text{are generally used}$$

for small and big catchments respectively.

Since the probability method and the empirical approach have their limitations and would give only the design peak discharge and not the complete design flood hydrograph, the Commission are of the view that these methods be used provisionally and every effort should be made to collect the required hydrological data at site and obtain the design flood by rational methods (e.g. unit hydrograph method) before the project designs are finalised.

## 3.9.0 IN THE CASE OF BARRAGE AND MINOR DAMS

In the case of permanent barrages, and minor dams with less than 50,000 acre ft. storages, the standard project flood or a 100-year flood, whichever is higher is to be adopted.

In standard project flood may be defined as a hydrograph representing run off from the Standard project storm. The Standard Project Storm is defined as one which is "reasonable capable" of occurrence over the basin in question. This is not as definitive as description as that for probable maximum storm. It may be taken generally as the largest storm which has occurred in the region of the basin during the period of weather records. It is not maximised for most critical atmospheric conditions but it may be transposed from an adjacent region to the watershed under consideration.

3.10 The initial reservoir level before the impact of the spillway design flood has to be taken as at full reservoir level. In regions experiencing prolonged floods where storms in quick design flood proceeded or succeded by a flood of once in 25 years frequency. The interval between these two floods (peak to peak) may be taken as 3 or 5 days according to as the region lies in an annual rainfall zone of more than 40" or less than 40" respectively.

3.11 To provide for mechanical and other failures, it was decided to assume some gates as inoperative with a maximum of 10 per cent and minimum of one gate. For this purpose the designer may be permitted to. increase permissible stresses treating it as an extraordinary occurrence, like earthquake.

## 3.12 IN THE CASE OF WEIRS, ACQUEDUCTS ETC.

For pick-up weirs, a flood of 50-100 years frequency should be adopted according to its importance and level conditions.

Waterways for canal acqueducts should be provided to pass a 50-100 years flood, but their foundations and freeboard should for a flood of not less than 100 years return period.

In case of cross drainage works, which carry highways or railways, waterways provided should also satisfy the respective standard code of practice of highways or railways.

3.13 Each site is individual in its local conditions, and evaluation of causes and effects. While, therefore, the norms, mentioned herein above, may be taken as the general guide lines, the hydrologist, and the designer would have the discretion to vary the norms, and the criterion in special cases, where the same are justifiable on account of assessable and acceptable local conditions; these should be recorded and have the acceptance of the competent authority.

I. Floods for various return periods where long term flood peak data are available.

II. Distribution of silt load in the reservoir and estimation of total loss of reservoir space on account of silting.

## 4. PRE-IRRIGATION SOIL SURVEY AND DRAINAGE

### Soil Survey

4.1 On topographical maps, to a scale of about 1/1500 of the project command area grid squares of about 100 ha. for flat areas and smaller grids where topography is undulating, should be established. Soil map of India is appended at Appendix VI.

4.2 Rapid reconnaissance survey may be carried out with traverses about 2 km apart. Augerholes and profiles should be taken at the rate of two per sq.km. covering the whole of the commanded area. Detailed soil survey should then be done for the problem areas such as those with high water tables, which are saline/alkali affected are water logged or have low permeability. For the problem area augerholes and profiles should be taken at the rate of one per sq.km.

4.3 Soil sampling data should be collected upto a depth of about 3 m. Test pit method of sampling may cover about 5 to 10% the total command area.

4.4 Observation wells suitably spread over the command area should be selected and water levels observed during monsoon and non-monsoon months for about 5 years.

4.5 Location of pits, augerholes and observation wells should be shown on the topographical map indicated in 4.1 above.

4.6 The soil data collected should include the following:-

i) Soil depth
ii) Soil texture classification
iii) Ph. value
iv) T.S.C. permeability
v) Water infiltration rates
vi) Available moisture holding capacity (upto 9 metres)
vii) Salinity and Alkalinity
viii) Calcium Carbonate Content
ix) Base exchange and fertility.

Water samples should be taken of the surface and ground water and tested for their quality.

The technical series 3–section I: soil survey and land classification brought out by Union Ministry of Food and Agriculture during 1970 may be referred to for detailed procedure.

4.7 Soil map of the command area and a table giving area in ha. for each soil group should be prepared. Area in ha. falling under each land irrigability class using standard land classification system should be shown. A chart should show the criteria used in standard land irrigability classification with definitions of each land class.

4.8 CROPPING PATTERN

i) Present cropping pattern giving area in ha. under different crops now grown with or without irrigation under each soil group and their present yields should be surveyed.

ii) Proposed cropping patterns giving area in the under different crops to be grown under different soil groups and their expected yields should be determined in consultation with the State Agriculture Department.

## 4.9 IRRIGATION

Duty and delta for each crop being irrigated in the neighbouring areas should be studied.

## 4.10 IRRIGATION WATER REQUIREMENT

Investigations shall be done to determine the irrigation water requirements at the outlets in consultation with the State Agriculture Department.

## 4.11 DRAINAGE

i) The area, depth and duration of flooding in the project command should be determined.

ii) Areas with higher water tables should be demarcated and causes thereof such as seepage from rivers or from higher lands, excessive irrigation or due to soil texture and depth of impermeable strata, relative permeability of surface and subsurface soils in the vertical or horizontal directions, etc. should be investigated.

iii) The flood disposal capacity of existing drainage system should be surveyed including existing outlet capacities etc.

iv) Areas needing post project drainage should be worked out. Special consideration should be given to land reclamation where land is alkaline/saline.

v) Alignment of existing and proposed drainage systems should be shown on the contour project command area plans.

vi) Typical drainage systems should be investigated for the different terrains encountered in the project area.

## 5. SPECIAL SURVEY FOR HYDRO-ELECTRIC PROJECT

The surveys of hydro-electric project shall include:

i) Present position of power supply in the region, system loads, load factor, kW hrs. generated per kW installed.

ii) Extent of firm power available from the scheme and also from the grid after commissioning of the plant, extent of secondary power etc.

iii) Details of major loads to be served, future peak and energy demands, anticipated system load factor.

iv) Investigation regarding earth resistivity in connection with sub-station designs.

v) The survey plan should cover an area sufficient to include switch yard and alternative plant layouts and should give contour at intervals of 5 m. Low water level, maximum observed flood level, rock outcrops sand shoals etc. at the power house site will be indicated therein.

vi) Maximum and minimum monthly temperature and maximum variation in daily temperatures for each month should be recorded.

vii) Chemical and petrographic analysis of river water should be carried out and recorded.

## 6. CONSTRUCTION MATERIAL INVESTIGATIONS

6.1 A map showing the location of the sources of construction material required with transport facility to work site should be given rock coarse and fine aggregates, pozzolans if proposed to be manufactured locally, soil for use in earth dam, dykes etc.

6.2 An estimate of the quantities available at various locations of the construction materials. (It is prudent to locate in advance quantities sufficiently in excess of the estimate requirement).

6.3 Reports on tests carried out on the various construction materials. The test procedures and other details shall be as per the relevant Indian Standard Specifications.

6.4 Following investigations are to be done for establishing suitability:

### 6.4.1 CONCRETE AND MASONRY DAMS

Geological and related characteristics of aggregates, including:

- i) Type of deposits.
- ii) Classification and characteristics of rocks.
- iii) Chemical suitability of aggregates.
- iv) Strength tests.

b) Investigations for the availability of natural and artificial pozzoiona with their characteristics.

c) The construction materials should be tested for:

- i) Petrographic analysis of sand and rock samples.
- ii) Grading and physical tests of sand and rock samples to assess their suitability as construction materials.
- iii) Preference of reactive aggregates in the area.

iv) Pozzolonic materials.

v) Strength of permeability tests.

### 6.4.2 EARTH AND ROCKFILL DAMS

a) Plans and sections should be made of the borrow area showing the location and logs of test pits spaced about 150 m apart and demarcating different types of soil.

b) Soil samples should be tested for:

   i) Mechanical analysis
   ii) Atterberg limits
   iii) Proctor compaction
   iv) Permeability
   v) Triaxial shear tests with pore pressure measurements under OMC and saturation conditions
   vi) Solubility tests in soils with high soluble content.

c) The sand and gravel to be used for filters should be tested for suitability as for concrete aggregate.

d) Rock for rockfill shall be tested for:

   i) Poresity;
   ii) Compressive strength;
   iii) Durability;
   iv) Alkalin reaction;
   v) Hammer Drop fest.

## 7. COMMUNICATIONS

Maps should be prepared showing the following facilities during construction and completion phases of the project:

a) Existing and proposed road, water and rail routes with information on load and size limitations.

b) Telephone and telegraph lines.

c) Sources for obtaining power with transmission lines routes.

d) Re-routing of the communication system is disrupted due to the construction of the project.

## 8. CONSTRUCTION PLANNING

8.1 Planning of river diversion arrangements and investigations for structure such as coffer dams, channels diversion, tunnels etc.

8.2 Haul roads etc.

8.3 Construction plant requirements and plant planning with particular reference to supply of power, water compressed air and other equipment required for construction.

8.4 Store and workshop facilities.

8.5 Planning of construction colony and facilities.

Appendix III

## SEISMIC COEFFICIENTS FOR SOME IMPORTANT TOWNS

| Town | Zone | Horizontal Seismic Coefficient h |
|---|---|---|
| 1 | 2 | 3 |
| Agra | III | 0.04 |
| Ahmedabad | III | 0.04 |
| Ajmer | I | 0.01 |
| Allahabad | II | 0.02 |
| Almora | IV | 0.05 |
| Ambala | IV | 0.05 |
| Amritsar | IV | 0.05 |
| Asansol | III | 0.04 |
| Aurangabad | I | 0.01 |
| Bahrich | IV | 0.05 |
| Bangalore | I | 0.01 |
| Barauni | IV | 0.05 |
| Bareilly | III | 0.04 |
| Baroda | III | 0.04 |
| Bhatinda | III | 0.04 |
| Bhilai | I | 0.01 |
| Bhopal | II | 0.02 |
| Bhubaneswar | III | 0.04 |
| Bhuj | V | 0.08 |
| Bikaner | III | 0.04 |
| Bokaro | III | 0.04 |
| Bombay | III | 0.04 |
| Burdwan | III | 0.04 |
| Calcutta | III | 0.04 |
| Calicut | III | 0.04 |
| Chandigarh | IV | 0.05 |
| Chitradurga | I | 0.01 |
| Coimbatore | III | 0.04 |

| 1 | 2 | 3 |
|---|---|---|
| Cuttack | III | 0.04 |
| Darbhanga | V | 0.08 |
| Darjeeling | IV | 0.05 |
| Dehradun | IV | 0.05 |
| Delhi | IV | 0.05 |
| Durgapur | III | 0.04 |
| Gangtok | IV | 0.05 |
| Gauhati | V | 0.08 |
| Gaya | III | 0.04 |
| Gorakhpur | IV | 0.05 |
| Hyderabad | I | 0.01 |
| Imphal | V | 0.08 |
| Jaipur | II | 0.02 |
| Jamsedpur | II | 0.02 |
| Jhansi | I | 0.01 |
| Jodhpur | I | 0.01 |
| Jorhat | V | 0.08 |
| Jabalpur | III | 0.04 |
| Kanpur | III | 0.04 |
| Kathmandu | V | 0.08 |
| Kohima | V | 0.08 |
| Kurnool | I | 0.01 |
| Lucknow | III | 0.04 |
| Ludhiana | IV | 0.05 |
| Madras | II | 0.02 |
| Madurai | II | 0.02 |
| Mandi | V | 0.08 |
| Mangalore | III | 0.04 |
| Moghyr | IV | 0.05 |
| Moradabad | IV | 0.05 |
| Mysore | I | 0.01 |
| Nagpur | II | 0.02 |
| Nanital | IV | 0.05 |
| Nasik | III | 0.04 |
| Nellore | II | 0.02 |
| Panjim | III | 0.04 |
| Patiala | III | 0.04 |
| Patna | IV | 0.05 |
| Pillibhit | IV | 0.05 |
| Pondicherry | II | 0.02 |
| Poona | III | 0.04 |
| Raipur | I | 0.01 |
| Rajkot | III | 0.04 |
| Ranchi | II | 0.02 |
| Roorkee | IV | 0.05 |
| Rourkela | I | 0.01 |

| 1 | 2 | 3 |
|---|---|---|
| Sadiya | V | 0.08 |
| Simla | IV | 0.05 |
| Sirojni | I | 0.01 |
| Srinagar | V | 0.08 |
| Surat | III | 0.04 |
| Tezpur | V | 0.08 |
| Thanjauvr | II | 0.02 |
| Tirunchirapali | II | 0.02 |
| Trivandrum | III | 0.04 |
| Udaipur | II | 0.02 |
| Varanasi | II | 0.02 |
| Vijaywada | III | 0.04 |
| Visakhapatnam | II | 0.02 |

Appendix IV

No. DW.II-11(8)/68
Government of India
Ministry of Irrigation & Power

New Delhi, the 23/24 June, 1969

## MEMORANDUM

Sub: Allowance for Seismic Forces in the Design of River Valley Projects, Setting up of a Standing Committee.

After the Koyna earthquake, the necessity has been felt for a high level inter-disciplinary official body to advise on the design Seismic co-efficients for dams and other structures of Irrigation and Power Projects. In consultation with the Ministries of Tourism and Civil Aviation and Petroleum, Chemicals, Mines and Metals (Department of Mines and Metals) Standing Committee of the following composition is hereby constituted:

| | | |
|---|---|---|
| 1. | Member (D&R), Central Water & Power Commission. | Chairman |
| 2. | Director, Seismology, Indian Meteorological Department, New Delhi. | Member |
| 3. | Shri V.S. Krishnaswamy, Director Engineering Geology, Division, Geological Survey of India, Northern Region, Calcutta. | Member |

The Standing Committee will meet periodically as required and advise the various authorities on matters referred to it.

Sd/- N.C. Saksena
23.6.69
Joint Secretary to the Govt. of India.

F.No. 23/35B/72-TE
Government of India
Central Water & Power Commission
(Water Wing)

New Delhi, the Dec., 1972

To

The Secretary to the Govt. of

________________________

________________________

Sub:- Irrigation & Multipurpose Projects -
Formulation and submission of.

Sir,

A reference is invited to this office letter No. 23/35/71-TE, dated 28th February, 1972 with which a copy of Guide Lines on the above subject was enclosed. In continuation, a supplementary note dealing with "Irrigation & Power channels and canal structures" which is in elaboration of para 2.5.6 of the Guide Lines is enclosed for information and use.

Yours faithfully,

( H.J. Desai )
Director-TE

Encl: As above.

Copy with a copy of enclosures forwarded for information to the Chief Engineer, Public Works/Irrigation, Department for information in continuation of CW&PC No. 23/35/71-TE, dated 10.3.1972.

Encl:- As above.

Supplementary Note on the aspects of investigation, design and preparation of estimates of the Canals and Distribution System in supersession of para 2.5.6 of the main Guide Lines.

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## 2.5.6 IRRIGATION AND POWER CHANNELS AND CANAL STRUCTURES

(a) Plans to be attached

1. Index plan showing the entire canal system and the whole scheme.

2. The command area survey plan to a scale of 1/15000 with contour intervals of 0.5 m.

3. L-Section:- Along the canal alignments L-Sections should be prepared with levels at 50 m. intervals indicating the following details:

   i) Reduced distances.

   ii) Ground levels.

   iii) Canal bed levels.

   iv) Full supply levels and water surface slope.

   v) Depth of cutting and filling.

   vi) Type of canal, nature of soil where the canal is passing through (by giving test pit or auger hole data at about 500 m. intervals), value of 'M', had width, side slopes, full supply depth, free board, full supply discharge, width of bank, L/R, velocity, C.V.R., losses etc. for various reaches.

   vii) Location and data of off-taking channels.

   viii) Location and type of cross drainage works with hydraulic details, e.g. catchment area, H.F.L., Discharge etc. and loss of head provided at such C.D. Works.

   ix) Location of Railway Crossings with rail levels.

   x) Location of the structures such as bridges etc.

4. Cross-Sections:- Cross-sections of canals, at intervals of 100 m. specially for maximum cutting, maximum filling and partial cutting-filling, extending to 100 m. on either side of the centre line of the canal showing the following details, be given:-

- i) Bed width.
- ii) Side slopes and nature of soil.
- iii) Full supply depth and free board.
- iv) Widths of berms and ledges.
- v) Profiles of banks suitably designed providing adequate cover over saturation line assumed for the soils in banking with details of the impervious core if provided. Inspection and non-inspection path details.
- vi) Drainage arrangements.
- vii) For lined canals, details of lining and under-drainage arrangement behind it confirming to the relevant I.S. Codes

(b) Design of Canals:- The following data may be given.

1. Trial pit or auger hole data indicating the nature of soil met with along the alignment of the canal.
2. Transmission losses assumed in the Main Canal, Branches, Distributaries and Minors in the unlined and lined channels alongwith the justification for their assumption.
3. Cut-off statement showing the details of discharge required from tail to head considering the requirements of the off-taking channels and transmission losses etc.
4. Design calculations for adequacy of canal sections adopted indicating details e.g. formula adopted, values of constants, designed slopes, velocities allowed, C.V. Ratios, F.S. Depths, Free Board, bed width to depth ratio etc.
5. Technical and economical justification for lining if proposed.

(c) Cross Drainage Works:- The following information may be given.

1. L-Section and cross-sections of the drains, along with details of catchment areas, high flood discharge, observed H.F.L. alongwith canal data at the point of crossing.

2. Test pit or bore hole data for deciding the nature of foundation of structure.

3. At least outlined designs and drawings for a few typical structures. Designs should include waterway calculations and other items of hydraulic design.

(d) Drainage facilities and water logging:

Design of drainage channels is to be enclosed if such a provision is made in the Project Report.

(e) Distribution system:-

The following details may be given:

1. Plan showing alignment of the distribution system with the commanded area of each distributary.

2. Calculation of "Design Discharge" of each distributary inclusive of transmission losses.

3. Design of any sample distributary.

Appendix 8

# DUTIES & FUNCTIONS OF COST CELLS

No. 7(1)/66-Policy
GOVERNMENT OF INDIA
MINISTRY OF IRRIGATION AND POWER

New Delhi, the 30th Aug., 1969

To

All State Governments
Department dealing with Irrigation and Power

as per list attached

Subject: Report of the Rates and Costs Committee (Part.I,).

Sir,

I am directed to invite your attention to this Ministry's letter No.7(2)/62-Policy dated the 28th May, 1962 wherein the recommendations of the Rates and Costs Committee were communicated to the State Governments for necessary action. Recommendation No. 4 dealt with the establishment of Costing Cells in all River Valley Projects costing Rs. 15 crores and above. In pursuance of this recommendation, the following Model Pattern of Cost Engineering Cell for major River Valley Projects has been prepared and is recommended for adoption in projects costing Rs. 15 crores and above:-

I. Strength

| | | |
|---|---|---|
| 1. | Executive Engineer | 1 No. |
| 2. | Assistant Engineer | 3. Nos. |
| 3. | Overseers/Field Supervisors/ Cost Supervisors/Supervisors | 3 Nos. |
| 4. | Accounts Assistant | 1 No. |
| 5. | Steno-typist | 1 No. |
| 6. | Typist | 1 No. |
| 7. | Peon/Messenger | 2 Nos. |

## II. Duties and Functions

i) Drawing up of forms for collection of cost and progress data from the field and introducing the use of such forms.

ii) Allocation of expenditure in accordance with the approved classification of accounts.

iii) Analysing and processing the cost data received from the field and regularly working out the item rates for major items of works obtaining in the project during construction.

iv) Publishing regularly the running rates and progress obtained in the field for the information of Chief Engineers and the Administration.

v) Analysing high costs and bringing them to the notice of the Chief Engineer for any remedial measures

vi) Studying the trend of major item rates and publishing monthly the expected variation in the estimate.

vii) Collecting and maintaining detailed records of individual plant and equipment performances.

viii) Preparation of revised estimates and budgets.

(ix) Limited Time Studies.

## III. Number

The size of a major river valley project and consequently its cost depends on

a) the volume of work like masonry, concrete and earthwork involved in a structure like a dam or a barrage, or canal and canal structures, etc. and

b) the number of dams, barrages, canal systems, etc., in a project.

In the case of (a) above, the strength of the cost cell would not require any increase merely because of the high project cost. The cell suggested would be suitable for projects costing Rs. 15 crores and above. In the case of (b) above, for each major dam or barrage or canal system a separate cost cell may be necessary.

IV. Requirement for department work/contract work

The model cost engineering cell suggested is for major river valley projects to be done departmentally. No cost cell is necessary for projects executed through contractors.

Yours faithfully,

Sd/-
(S.N. SINGH)
UNDER SECRETARY TO THE GOVERNMENT OF INDIA

Copy forwarded to:-

1. Ministry of Finance (I&P Branch), New Delhi, w.r.t., their u.o. no. 3307-I&P/69, dated 2.8.1969.
2. The Central Water and Power Commission (WW), New Delhi w.r.t. their u.o.no.1/3/69-Cost Control dated 21/23.6.1969.
3. River Valley Projects Control Boards as per list attached.
4. All Project Sections in this Ministry.

Sd/-
(S.N. SINGH)
UNDER SECRETARY TO THE GOVERNMENT OF INDIA

Appendix 9

## Measures adopted in different States and projects for rehabilitation of persons displaced due to construction of reservoir projects

### A. Agricultural Land

| | |
|---|---|
| ORISSA<br>(Balimela Project) | For cultivation, reclaimed land is given to displaced persons to the extent of 5 acres per family. The land is reclaimed at Govt. cost. In addition a grant of Rs. 100 per family is given for opening the agricultural land. |
| MYSORE | Reclaimed land is provided for cultivation. This is given free of cost to tenants and agricultural labourers. |
| MADHYA PRADESH | Land for land is given to displaced persons if Govt. land is available and agreed to by both the parties. |
| HIMACHAL PRADESH | All facilities for agriculture are to be made available to persons who are ousted on account of construction of a project. |
| ANDHRA PRADESH<br>(Srisailam & Pochampad Projects) | Land equivalent to the extent of land acquired from oustees but subject to a maximum limit of 5 acres of dry land or 2 acres of wet land is given free of cost. For this purpose only those living on cultivation for 3 years prior to the development are considered. In addition a subsidy for reclamation of land at Rs. 100 per family is given to the persons affected. |
| TAMILNADU<br>(Parambikulam Aliyar project) | Compensation for agricultural land is given. |
| BEAS PROJECT | Land is to be given in the Rajasthan Canal project area to each oustee who possessed land subject to a limit of 15.625 acres per oustee. |

## B. Housing

| | |
|---|---|
| ORISSA<br>(Balimela Project) | Oustees are resettled in new villages containing 40 families. Each family is allotted 0.20 cents of land for homestead purposes. In addition a grant of Rs. 300 is given per family for house building. |
| MAHARASHTRA | Land is acquired for new villages to resettle the displaced persons. |
| MYSORE<br>&<br>KALINADI HYDEL PROJECT, MYSORE | Land is selected and acquired by Government for resettlement of persons at new sites. Expenses on account of levelling the new sites, etc. are borne by the Government. Sites for dwelling and manure pits in the new areas are given free. The oustees are allowed to take free of cost the salvaged material from their properties acquired by the Government. |
| MADHYA PRADESH | Compensation for buildings located in areas to be acquired is paid at the prevailing market rates as fixed by Collector. |
| HIMACHAL PRADESH | Houses comparable reasonably with the ones acquired are to be provided for. |
| ANDHRA PRADESH<br>(Srisailam & Pochampad Projects) | Rehabilitation centres for accommodating affected persons are provided by the Government. At such centres, 10 cents of land for house building are given free per family to those whose lands have been acquired and 5 cents per family to those whose lands have not been acquired.<br>At places other than these centres, a cash grant of Rs. 500 per family is given to those whose lands are acquired.<br>Where houses and properties are to be acquired, a cash grant equivalent to 50% of the compensation paid for such properties, subject to a minimum of Rs. 500 and a maximum of Rs. 2000 per family is given.<br>Ex-gratia payment for construction of house @ Rs.300 per family is made. |

| | |
|---|---|
| TAMILNADU (Upper Dam of Parambikulam Aliyar project) | Compensation for house and other properties is given. Persons are permitted to take useful building material from their acquired houses at 25% of the cost. |
| BIHAR (Tenughat Project) | Land for homesteads, roads, wells, tanks, schools, pasture fields etc. is acquired by the Government. For this purpose available 'Gairmazorus Khas' Lands and lands under protected forest area are required and given free of cost to the displaced persons. However, the cost of temporary lands acquired for the purpose is paid by the displaced persons, except the landless displaced persons.<br>Rs. 25.00 per acre is provided for levelling of the land. |
| BEAS PROJECT | Oustees are to be resettled in the Rajasthan Canal project area. Such oustees who migrate to this are to be paid Rs. 425 per family. For those who decide not to migrate to the Rajasthan Canal project area, a cash rehabilitation grant of Rs. 250 per family is to be paid. These grants are also to be given to landless persons of all categories.<br>Katcha houses are to be built for oustees in chak abadi. Artisans, labourers, landless tenants, etc. are to be given house sites within the abadi area but no land as such. A subsidy for construction of houses and diggies is to be paid to oustees as per scale prescribed. |

### C. Shifting Charges

| | |
|---|---|
| ORISSA (Belimela project) | Shifting charges for resettling the displaced persons are to be borne by the project. |
| MAHARASHTRA | Displaced persons are paid for or provided transport for carriage of household kits and salvaged material from old houses to new village sites. |
| MYSORE | Free transport is given for shifting the salvaged material to the new village sites. |
| MADHYA PRADESH | No transport for shifting of household effects etc. is provided. |

| | |
|---|---|
| ANDHRA PRADEISH (Srisailam & Pochampad projects) | Transport charges for shifting are paid to displaced persons at specified mileage rates. |
| BIHAR (Tenughat project) | Displaced families are shifted to new resettlement sites through the agencies of the project at project cost. |
| BEAS PROJECT | Oustees migrating to Rajasthan Canal project area are to be paid transportation charges at the rates specified. Temporary transit camps at the railhead are to be provided for the oustees, when they go to the resettlement area for the first time. Transportation from transit camps to the respective 'abadis' is to be paid at Rs. 20.00 per oustee. |

## D. Amenities

| | |
|---|---|
| ORISSA (Balimela project) | Each new village for resettlement of displaced persons is provided with<br>1. One school building & one teacher's quarter,<br>2. one recreation centre,<br>3. one tank or well, and<br>4. link roads. |
| MAHARASHTRA | In the new villages school, temple, wells, internal roads, chowdi, street lights are provided. |
| MYSORE | Provision is made in new sites for<br>1. internal roads with cross-drainage works,<br>2. drinking water well at the rate of one well for 15 to 20 families,<br>3. panchayat or community hall building, |

4. primary school building,

5. temples in lieu of those existed at the old site, and

6. Gokatte for cattles.

| | |
|---|---|
| KALINADI HYDEL PROJECT MYSORE | Provision made in new villages for internal roads including drains, drinking water wells, temples, hospitals, schools, panchayat halls, society buildings and electric lighting including main power line. |
| MADHYA PRADESH | Displaced land owners themselves make arrangement for their rehabilitation. |
| ANDHRA PRADESH (Srisailam & Pochampad projects) | Wells, chavidi, approach roads, internal roads, drains, school buildings, temples, etc. are provided in the rehabilitation centres established by the Government. |
| BIHAR (Tenughat project) | Approach roads, community halls, latrines, store-cum-sale depots etc. are provided in the resettlement areas. |
| BEAS PROJECT | Facilities like diggies for drinking water, school buildings, hospitals, roads, etc. are to be provided to oustees at their new places of settlement. Transit camps provided for oustees will have drinking water, sanitation and camp equipment |